THE TELEGRAPHIC JOURNAL AND

Electrical Review.

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ELECTRIC TRAMWAYS COMING.

IF all we read is true, and we have no reason to doubt it, we are bound to acknowledge that our trans-Atlantic cousins are far ahead of us in the application of electricity as a motive power for tramways, and though the *systems* in vogue may not bear the mark of originality, the spirit with which the various enterprises have been undertaken is truly characteristic of the nation. The number of electric tramways in the United States of America can be counted by dozens, most of which are working successfully, and with surprising economy, as will be seen by the statements published in our journal from time to time. Several of these lines have been in operation for a couple of years, others are of a more recent origin, and a few are still in the "experimental stage." The Americans are fond of *systems*, but as far as our own observations go, we often find it hard to distinguish between them; the differences consist not, as the uninitiated would suppose, in the application of various distinct principles, but more in the variation of designs, some of which, for the sake of "variety," are of extraordinary appearance, and the changes relate mostly to peculiarly-shaped details in the modes of suspension of motors under the cars, and in the mechanical gearing used between the motors and driving wheels.

We, in England, recognise systems mainly by the methods of transmitting electric energy; thus there is the system of using the rails as conductors, the use of separate conductors running alongside the rails or overhead; then, again, underground conductors; and finally, the system which does not require any conductor, but in which stored energy is carried within the car. It is a remarkable fact, one worthy of record, that with the exception of the accumulator system, none of the electrical tramways in England ever went through the "experimental stage." The lines at Brighton, Portrush, Bessbrook-Newry, Blackpool, and Ryde, were all built to commence traffic at once, and almost every one had proved successful from the commercial point of view, as well as highly popular. Experience had to be gained in each, but that experience had to be paid for at a rate which materially swelled the working expenses. That the accumulator system has not progressed, commercially, as rapidly as the conductor systems, is partly due to the longer time it took to bring the secondary battery to the requisite state of perfection, and partly to prejudices which could only be removed with great difficulty; but the successful experiments with cars of this description in Berlin, Hamburg, Antwerp, and Brussels, will go far to inspire confidence, and we look to an early development in the application of this system, as it lends itself admirably to any existing lines without alteration to the permanent way or public road.

The often raised objections to the weight of accumulators can no longer hold good, since it has been shown that the same does not exceed a ton and a quarter, or less than 25 per cent. of the total weight of car and passengers combined. Taking the losses arising through the several conversions of energy into consideration, the consumption of coal at the charging station need not exceed 6 lbs. per car mile, which at the rate of 16s. per ton amounts to barely one half-penny for a two-horse car per mile run. But the amount of fuel consumed is really a small item in the working expenses of an electric tramway, therefore we need not say any more on this head. In the case of the Blackpool tramway, for instance, which is worked on Mr. Holroyd Smith's plan of underground conductors, the item of "coke, coal, and oil" in the balance sheet we publish on another page amounts to the insignificant sum of £270 13s. 5d., whilst the total working expenses are put down at £3,334 14s. 7d. The revenue account shows the sum of £5,125 17s. 3d. for the year ending October 31st.

We comment upon the working expenses elsewhere, and propose now to consider technical points only which bear upon the cost of the Blackpool tramway. The heaviest charge in the column of preliminary expenses is that for constructing the centre channel which carries the underground conductor with its electrical fittings, amounting to £8,354 14s. 3d., a remarkably heavy item considering that the line is barely two miles in length. It actually exceeds the sum of all the other important items, viz., buildings, engines, dynamos, motors, and 10 cars with their full equipment, by £1,045; the cost of the plant, rolling stock, tram shed, &c., amounting to only £7,309 8s. 2d. No doubt if a similar line had to be constructed now, the cost of this channel could be reduced considerably, perhaps by 30 per cent., but even then it would be large in comparison with the cost of accumulators, which, to do the same work with 10 cars, would not exceed £3,000 including a large reserve. The cost of Mr. Smith's underground channel is, however, only part of the expense which an *existing* tramway company would have, because of the necessity of removing the pavement and replacing it. Tramway directors and the public dread nothing more than interference with roads. But in the case of *new* tram lines the system of Mr. H. Smith will offer no difficulty in this respect and little extra expense. The depreciation of the underground conductor should be small, and if the line is short and well insulated the loss of energy will be comparatively trifling. We have already said that the consumption of fuel is only a fraction of the total working expenses. The depreciation of *accumulators* however is considerable in comparison with that of the underground conductor, but if we balance the greater depreciation in the one against the interest on the increased capital expenditure of the other, there will be little to dispute about. From various data in our possession we have come to the conclusion that in a well designed and properly

managed electric tramway, whether worked on the conductor system or on the accumulator system, the cost of traction, inclusive of depreciation, need not exceed three pence per car mile. This estimate, however, is based upon the employment of cars capable of carrying 40 to 46 passengers on average tram lines with reasonable gradients, such as occur in London, and providing that the conductors are of less than three miles in length, or in the case of accumulators carried *upon* the car, that the dead weight does not exceed 1½ tons. Each system has its own advantages, each will find its application according to circumstances, and we are convinced that electric traction on tramways will ere long receive as much attention in England as it is already receiving in America.

A NEW TELEPHONE REPEATER.

A DECIDEDLY novel arrangement for repeating telephone messages, and one that is at the same time adapted for use generally as a relay, says the *Electrical World*, has recently been devised and patented by Mr. Moses G. Farmer, the veteran electrician. In the accompanying illustrations, fig. 1 is a plan view of the apparatus, and fig. 2 a vertical central section of the same. The electro-magnetic or primary part of the device consists of two concentric helices, either or both of

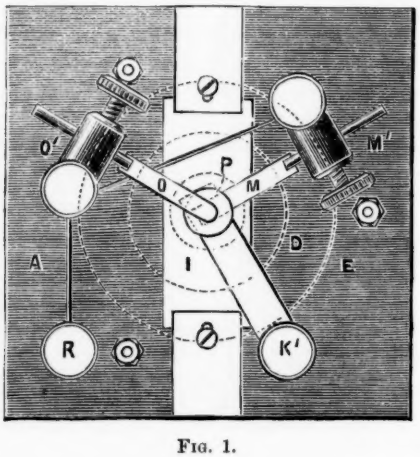


FIG. 1.

which may be divided into a number of sections or independent coils. Within the inner helix is a stationary soft-iron core composed of a number of separated or magnetically insulated tubular sections. Within the section are armatures, all of which are secured to a rod or tube, which is connected with the contacts or otherwise arranged to transmit its movements or vibrations to one or more of the contacts. Referring to the figures, it will be seen that A B are two circular heads of insulating material held together by the rods, C. Between the heads are the coils comprising the helices, of which the inner coil, D, is of comparatively coarse wire, with but few turns, while the other coil, E, is of finer wire, with a large number of turns. The coil E fits loosely over the coil D, and in the present case is divided up into a number of sections connected together.

The coil, D, surrounds a stationary tubular core composed of soft iron sections, F F. The sections, F, are shouldered at each end, and held apart by brass rings, *f*, the core being built up in this way and held firmly together by the heads, A B.

Within this tubular sectional core is a series of armatures, G, carried by a light brass tube, H. The armatures, G, are short tubes of soft iron with flanges, *g*, so as to contain a greater mass of iron at their upper ends. They fit loosely within the sections, F, and are separated from each other by brass rings, *g'*. The armatures are secured to the tube, H, and the sections, F, placed over them in building up the core, so that the heads or flanges, *g*, will be contained in the spaces between the sections, F, and be capable of such movement as will permit a limited longitudinal movement of the tube, H, through the core.

The tube, H, is secured at its upper end to a strip of mica, I, secured to the upper face of the head, A, over a central perforation therein. Its lower end extends down through the head, B, and is held in position there by two thin flexible metal straps, N. To the upper end of the tube or rod, H, or to the mica strip, I, is secured a metallic cup, K, containing a carbon button, *i*. Upon this rests a metal electrode or contact, L, which is a small platinum pin passed through the end of a thin resilient metal strip, M. Upon this rests a carbon button, P, in a socket carried by a resilient metal strip, O. The cup or socket, K, is electrically connected with a binding post, K', and the strips, M, O, are supported by adjusting holders, M', O', shown in the plan view, which are electrically connected together and to the binding post, R. Other binding posts, S, S, are placed on the base of the instrument—two for the inner and

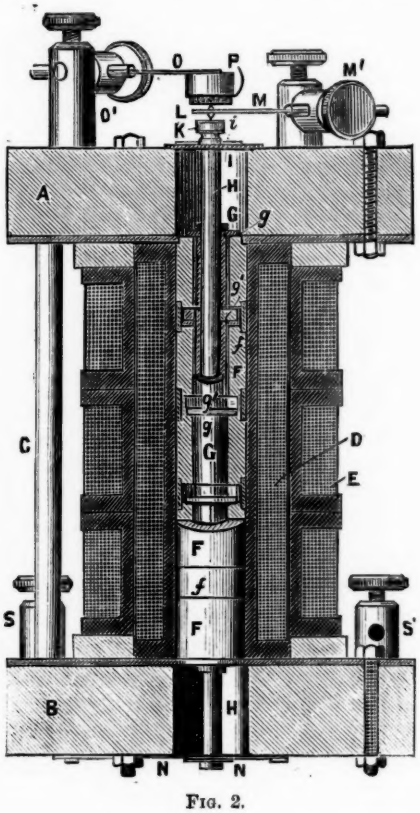


FIG. 2.

two for the outer coils. In preparing the instrument for use, the intermediate contact, L, is adjusted so as to press lightly upon the lower contact, *i*, and the upper contact is set so as to just touch the contact, L. When in operation, the coil, D, is connected up with a small battery, which furnishes sufficient current to magnetise the cores. The outer coils, E, are connected up in the primary or independent line, and the first part of the secondary or dependent line, which in practice is the primary circuit of an induction coil, is made through the contacts by connecting it with the parts, K R. The effect of the current flowing through the coil, D, is to magnetise both the sections, F, of the stationary core and the armatures contained within them, and by reason of their relative positions to impart the same polarity to their corresponding or adjacent ends. The upper end of each inner core or armature, being larger than the lower, and being also somewhat nearer to the lower end of the stationary section next above, is attracted by the core above and

repelled by that surrounding it. The current impulses in the coil, E, acting upon the core thus affected, tend to produce, by means of this conjoint attraction and repulsion, a movement or vibration of the inner cores or armatures in line with their axis, which vibrations, being imparted to the contacts, reproduce in the secondary or dependent circuit corresponding impulses.

THE COLOSSUS DYNAMO AT WORK.*

By WM. H. HALE, PH.D.

ON September 16th I had the good fortune to pay a visit to Lockport, N.Y., just in time to find the dynamo engaged in smelting its first run of metal, which was an alloy of aluminum and copper.

Although the process of electric smelting is capable of reducing the most refractory ores, and securing many costly metals, such as potassium, sodium, magnesium, and the like, besides metalloids, boron, silicon, &c., yet the company now aim especially to secure aluminum in large quantities, because of the many valuable properties of that metal and its alloys, and the almost infinite variety of uses and inexhaustibility of demand for them at the reduced price which this process renders possible.

Both the Cowles brothers, Eugene H. and Alfred H., the joint inventors of the electric furnace, were present —the latter having only the day before returned from Europe, where he had been exhibiting specimens of product as previously obtained by smaller dynamos at Cleveland, having secured, among other fruits of his trip, an order from Whitehead, manufacturer of torpedo boats, for 6,000 pounds of the 10 per cent. aluminum and copper alloy. No other visitor was present. The big dynamo was running at 380 horse-power, though capable of 500 horse-power when required. It was making 420 revolutions per minute, and, as the electricity was drawn off, it scintillated in a brilliant and continuous fusillade of sparks varying in colour from white to emerald green, and occasionally flashing out in a burst of unusual splendour, yet perfectly controlled and free from danger to the spectators.

The dynamo is driven by water-power. The waterways were constructed by Holley, and are replete with ingenious appliances for utilising all the power there is, and for keeping the water at a uniform level. The water wheels used are double turbine with horizontal shaft, each turbine being 8 feet in diameter. The dynamos—for there is also a smaller one—occupy a room by themselves intermediate between the turbine wheel room and the furnace room.

Passing to the furnace room, we see where the energy of the dynamo is being expended. The furnaces are built larger for the Colossus than those used with smaller dynamos, and are charged with 60 pounds granulated copper, 60 pounds corundum, and 30 pounds coarse charcoal, besides the pulverised lime-coated charcoal used as packing. This mixture contains over 32 pounds of aluminum or about 54 per cent. of the corundum. Into the furnace thus charged pours the current from the Colossus, fusing the almost infusible corundum like wax, causing its molecular structure to be broken up into its elements, and raising the temperature of the entire mass to a very high heat. Vent holes are left in the covering of the furnace, through which escape the liberated gases and some of the volatilised aluminum, the whole glowing with a bright flame which sometimes darts up to the height of many feet. The ampèremeter on the wall shows with what force the current is flowing, and the attendant must watch it closely to keep it at the desired gauge. A force of 2,000 to 2,400 ampères is generally preferred. As the index approaches the higher limit, the carbon electrodes are from time to time drawn asunder, till at last they stand wide apart, and the current flows freely through the entire furnace. The process of reduction takes about two hours.

Returning to the dynamo room, we find at the end of the run that the bearings of Colossus are not raised to the temperature of blood heat; and it proves to be the case that it may be run continuously without becoming overheated, thus demonstrating the excellence of its construction under the personal supervision of Mr. Brush. The bane of dynamos is overheating.

What do we find in the furnace at the end of the reduction? The products of the electrical furnace have furnished the theme for several papers already before scientific societies, and will supply a probably fruitful field of research for time to come. Since the first run of the dynamo, I have on several other occasions visited the works and seen the charges withdrawn from the furnace. The product appears in the form of a fused mass of metal embedded in the surrounding carbon. Most of this mass is an alloy of copper and aluminum, varying much in the proportion of the two. Mostly it exceeds the 10 per cent. of aluminum which gives the alloy of maximum strength, and is a brittle white metal, which is again fused with the addition of more copper to such an alloy as may be required.

But the furnace gives many other products. Sometimes there are found small fused rubies and sapphires. The sub-oxide of aluminum—never found in nature, and never before known to exist or to be capable of formation—is always present in larger or smaller qantities. I have also seen specimens of beautiful white fibrous alumina. With other charges, sub-oxides of silicon and titanium are found—very curious products indeed. The intense heat even partially fuses the carbon, and the electrodes are converted into graphite.

The rush of visitors has been so great that the company has been compelled to restrict facilities for admission latterly.

Important economical as well as scientific results have been already attained by the dynamo. The price of aluminum alloys has been reduced to a scale adopted by reckoning the value of the contained aluminum at $2.50 a pound, previous sales of that metal having been at the rate of 75 cents an ounce.

The 10 per cent alloy is said to be the strongest metal known, though alloys of a less per cent. have great utility, being tougher, but not so strong. Krupp cannon require a tensile strength of 70,000 pounds per square inch of wrought steel, the labour on which raises its cost to 75 cents or a dollar a pound. Some specimens of the alloys made by the Colossus, which are simply cast, not wrought, have recently shown the phenomenal strength of 131,000 pounds per square inch.

Since writing the above, I notice the statistics of production of different metals in the United States for 1885, as given in the *Scientific American* for November 6th, 1886. In that table the whole amount of aluminum produced during the year is stated as 3,400 ounces, aluminum being then regarded as a precious metal.

The capacity of the Colossus will enable it to reduce a larger amount than this, in the alloy with copper, within the period of 24 hours.

* *Scientific American.*

UNSUSPECTED DANGERS WITH FRICTIONAL ELECTRICITY IN BLASTING.

SOME years ago, writes W. E. Irish in the *Electrical World*, when I was engaged in assisting to carry out a series of experiments in the firing of torpedoes and mines by means of electricity, an incident occurred which nearly resulted in a most serious calamity through the want of knowledge regarding the power of induction.

About a week after the commencement of a long series of experiments, several charges of gunpowder, gun-cotton and dynamite were submerged in a river

about one hundred feet apart, the object being to learn what the effect of each would be when fired under the same conditions. The firing station and position of the charges in the river were on this occasion totally obscured from each other and about one mile apart. The cable employed to connect the charges with the firing apparatus consisted of a stranded copper conductor well insulated with "Hooper's compound." Two lines were used for firing the charges, and a third, or special cable, of the same description was laid for communicating between the two points by telegraph. The three cables were laid on the grassy land parallel to, but separated from each other by a space of a few inches throughout the greater part of their length. Electricity for firing the charges was obtained from Baron Von Ebner's ebonite-disc frictional machine, which is too well known to need description.

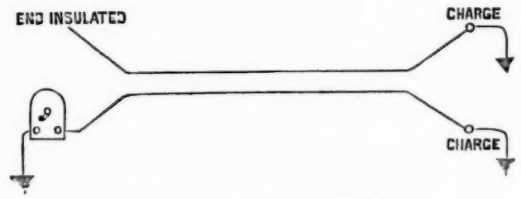
The two ends of the cables at the river were each connected to a charge, while at the firing station one end was carefully sealed and suspended in the centre of the firing room as a precaution and guard against the possibility of its coming in contact with the firing battery or machine. The other end was connected to the electric generator in connection with the charge to be fired first.

Final arrangements having been completed and all made ready, instructions were telegraphed to fire No. 1 charge, which was carefully and correctly done. Scarcely, however, had the firing key been depressed when word was wired from the river "to stop further operations, and leave everything at the firing station in the exact position it then occupied, as two charges had been fired instead of one only, as directed; and that in consequence a boat and party of men engaged near the charge which ought not to have been fired had most miraculously escaped being blown to pieces." This was declared by the operators at the firing station to be impossible through any action or neglect on their part. The matter, however was too serious to be left without a thorough and searching investigation. There was no question as to the second charge having been fired, and a careful examination of the cables between the points, immediately after the occurrence, failed to show the slightest sign of their having been tampered with. The evidence tended to locate the cause at the firing station, but how or by what means the charge was fired was quite unaccountable to all, and remained a matter of conjecture for several days, as the spare end of the cable had remained securely sealed and suspended, and was at the time of firing many feet away from the electric generator. A very careful examination and insulation test of the end of this cable in the firing station proved that it had not been injured or tampered with in any way.

It was determined to unravel the mystery, if possible, and we set resolutely to work and were not long in discovering that under precisely the same conditions the same result was always obtained. One gentleman ascribed the cause to be the detonation of the charge fired, but we had satisfied ourselves from the outset that such was, under the circumstances, very unlikely indeed. Experiments and investigation led us eventually to discover the fact that the firing of the second charge was due to induction. This, at first, we found some difficulty in proving to the entire satisfaction of the gentleman who stood up so stoutly for the detonating theory. To remove all further doubt, and for the information of all concerned, two half-miles of the same description of cable were placed one foot apart throughout their entire length, fuses being connected to the cables at one end to represent the charges, and the wire being then grounded as before, as shown in the accompanying diagram. To one of the cables at the firing station the frictional machine was connected, while the other end was carefully sealed and suspended in the same room as before and at least ten feet away from the electric generator. The discs of the machine were given twenty revolutions and the condenser was discharged, when both fuses fired. Other tests were then made, as given in the following table, to discover the greatest distance through which this inductive action would fire a charge, the wires being arranged as described above.

Distance of cable apart in feet.	No. of revolutions of the disc.	No. of charges fired.	Distance of cable apart in feet.	No. of revolutions of the disc.	No. of charges fired.
6	20	2	20	30	2
3	4	2	30	30	2
3	4	1	40	30	1
9	20	2	40	30	1
12	20	2	40	40	1
15	10	1	40	50	1
15	20	1	40	50	1
15	30	2	35	50	1
20	30	2	30	50	2
25	30	2	30	50	2

It would be dangerous on cables running parallel and within forty or fifty feet of each other, to employ the frictional machine when more than one charge is connected.



CHARGES FIRED BY INDUCTION.

It will be seen from the above table that a charge connected with a cable, one end of which was insulated, could be fired by the inductive action of another cable running parallel to and separated from it by a space of thirty feet when one class of electric generator was employed; whereas, with a different generator the second fuse was not fired, even when the cables were tied or twisted together, as will be shown by the following tests.

The frictional machine was now removed, and tests were made with dynamic machines and voltaic batteries, but in no instance did we succeed in firing more than the one charge, and then it was the one connected in circuit with the machine or battery, even when the wires were as close together as it was possible to get them.

These experiments clearly prove that the detonation from the primary charge fired was not the cause of the second one exploding, and that the action was alone due to induction. Had it been due to the detonation, both charges would have been fired as readily by a dynamic machine or voltaic battery as with the static machine.

The writer is well aware that one charge is frequently fired by the detonation of another when the two are within a limited distance of each other.

This power of induction could be put to good use, particularly in naval warfare, in firing and destroying the enemy's mines. It may also be interesting to know that with a 30-cell Grove battery and similar cable to the above, we succeeded in firing through a fault made by stripping off twenty-four inches of the insulation and submerging the bare wire in the sea. With an induction coil, we failed to fire through a fault in the insulation only sufficient to expose the conductor to the eye. Wheatstone's magneto-exploder fired the charge through a leak $\frac{1}{24}$th of an inch long, but failed through a fault exposing $\frac{1}{8}$th inch of the conductor. Siemens's dynamo machine fired the charge through a leak exposing a surface of $\frac{3}{10}$th inch, but failed to do so with a larger fault. Von Ebner's frictional machine fired through a leak of $4\frac{1}{2}$ inches of bare conductor. It also fired the charge through a perfect break in the conductor. A 4-cell Grove battery fired through $\frac{3}{8}$th inch leak, but failed to do so through $\frac{3}{4}$ inch.

These rough and ready tests and experiments were made to show as simply and quickly as possible, to men having little electrical knowledge, the most suitable

firing apparatus to use under certain circumstances and conditions.

I have not seen any published information relating to this subject, and as the facts as here stated do not appear to be generally known, I think them of sufficient interest to record, in order that accidents may be avoided by the use of such apparatus in the hands of the inexperienced.

THE LAW OF WINDING SELF-REGULATING MOTORS.

PROF. SILVANUS THOMPSON complains, in our last, that in our article on electric-motors in America we give the following as the "Sprague law" of winding self-regulating motors. "The number of turns in the shunt coil must bear the same ratio to the number in the series coil as the resistance of the shunt coil bears to the sum of the resistance of the series coil and the armature." He very properly points out that this is a mere development of the well-known theory of self-regulating motors of Profs. Ayrton and Perry, published in May, 1883, and says that he so treated it in the first edition of his work on "Dynamo-electric Machinery," published in the summer of 1884. We quite agree with the learned professor that the "law" is a mere development of the Ayrton and Perry theory, and wish to draw his attention to the first of the articles in question, on page 427, where we stated that the *Electrical World*, of New York, was responsible for the connection of Mr. Sprague's name with the principles alluded to in the articles. We further pointed out that Mr. Sprague's work was founded to a great extent upon principles not unknown in this country, and that what was claimed as Mr. Sprague's "main principle" was at any rate as old as the differential motor of Ayrton and Perry.

Prof. Thompson will therefore see that we are quite at one with him on this subject.

At the same time, we think this matter has a historical rather than a practical interest. Although theoretically differential motors may be the right thing we do not believe they are ever likely to have an extended practical application. There are some objections to the use of differential motors which are no doubt responsible for the failure of the Ayrton and Perry machines to obtain a footing amongst users of motors; and fortunately since Mr. Mordey pointed out that pure shunt motors could be made to give very excellent results in relf-regulation there has been no occasion to fall back on the differential principle. We imagine that Profs. Ayrton and Perry found a differential field winding indispensable because their motors, on account of the very marked magnetic polarity set up in the armatures, working as they did with very weak fields, required an enormous correction. In fact, Profs. Ayrton and Perry appear to have developed their theory of motor action—which is all right as a theory—and then invented their motor to fit into and to justify and illustrate that theory. The theory and the illustration formed an admirable whole.

It is curious to note how extremes meet. We have more than once had to deplore the attempts made, on the part of those who had only "a little knowledge," to attain perfection in motors by trying to get rid of what they considered a very undesirable feature, viz., an opposing E.M.F. which "tried to stop the current." And yet in the motors in which the differential principle is most necessary we have at least an approach to the same idea. We have a very weak field, and an armature which when traversed by a sufficient current simply twists that field out of all shape.

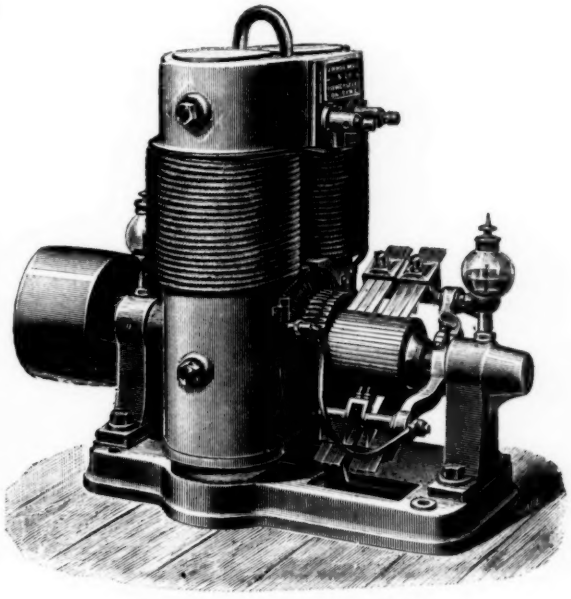
A differential field will, we think, only be used in special cases with modern motors, where it is required to have extremely fine speed regulation, on constant E.M.F. mains, at least. In very few instances is it as necessary to obtain a constant speed in a motor as it is to obtain constant E.M.F. in a dynamo, as, fortunately, motors are seldom required to drive apparatus so sensitive to changes of speed, as are incandescence lamps to changes of E.M.F. The analogy between constant speed in motors and constant E.M.F. in generators does not altogether apply as regards any supposed equal necessity for compounding or correcting in the two cases. While in generators, it is almost always desirable to over correct them, that is, to give them rising instead of straight characteristics; in motors over-correction will seldom be called for—it will not often happen that a motor is required to run faster with a heavy load than with a light one.

However, we may have more to say on this point on a future occasion.

THE "CASTLE" DYNAMO.

MESSRS. J. H. HOLMES & CO., of Newcastle-on-Tyne, have brought out a series of different sized dynamos of a type which they have distinguished as the "Castle." They have adopted the single horseshoe form modified so as to produce a maximum of efficiency with a minimum of labour in construction.

The cores of the field-magnets are of well annealed wrought iron bars which are bored near the ends to receive the armature, and castings are closely fitted on to provide the requisite polar extensions, so that the



lines of force at the poles nearly all pass through wrought iron. At the top the bars are joined by a very massive cast iron yoke which is so well connected magnetically that when the machine is working there is scarcely any exterior magnetism perceptible in its neighbourhood. The armature is constructed of thin charcoal iron plates supported by a special arrangement which truly centres the core and secures that exact balance so necessary to the steady working of the machine, at the same time leaving the interior open to free ventilation. Only a single layer of conductor is wound on the armature and owing to its special section, these machines, we are informed, give the greatest possible output for their size. The brush holders are arranged so that the brushes may be placed out of contact with the commutator by merely pulling them back without altering the adjustment of springs. The number of parts in the commutator is large and there is no sparking at the brushes. No pains have been spared to render the machines mechanically perfect, and the long bearings with special arrangement for lubrication will commend them to engineers. All the work is executed by skilled workmen, with the

aid of the best modern machinery; and whilst no attempt has been made to sacrifice weight for efficiency, yet by the due proportioning of parts the weights will be found to be considerably below those of many well-known types. The electrical details have all been carefully worked out and the larger machines give an efficiency (of conversion, we presume,) of over 95 per cent. with an unusually small amount of copper on the field-magnets. Special attention has been paid to rendering the smallest sizes of these machines efficient, so as to get the greatest possible number of lights from motors of small power. One of these dynamos has been working for a year in a mine, where it runs without stopping from Monday morning to Saturday night, and without showing any signs of undue heating or wear.

RECENT IMPROVEMENTS AND ADVANCES IN THE APPLICATION OF ELECTRICITY TO RAILWAY WORKING.

THE SINGLE NEEDLE BLOCK INSTRUMENT.

THE earliest form of block employed was the needle instrument. The handle carried over to the left inclines the needle to the right, which constitutes the "all right" or "line clear" signal, whilst the reverse action is employed to produce the contrary signal "train on line;" the vertical position of the needle indicating "line blocked." Thus, before a train is started from, say A to B, A is required to obtain the "line clear" signal for it. This is accomplished by a given signal on the bell, accompanied in some instances by a certain number of beats on the needle. Station B thereon, provided the section between that station and A is clear for the train to approach, fixes the needle of his block instrument communicating with A over to the "line clear" side. The signal is recorded upon A's instrument, and the train is allowed to proceed. On its departure A duly notifies B of the same, when B reverses the position of the needle, indicating that there is a "train on line," and this signal is retained until the train reaches B and has been duly signalled into the next station ahead.

In order to retain the handle of the instrument, which, as will be understood, is the commutator by which the currents, positive or negative, are brought into operation, in the required position for the line clear or train on line signal, a metal block, with a double inclined plane, in cross section somewhat of the shape of the letter A, is provided immediately underneath the handle of the instrument. A hole is bored vertically through the barrel of the handle or commutator, so that when the handle is held over to either side a conical pin, passed through this hole, shall rest upon one or the other of the inclined planes of the metal block. The pin is attached to the front of the instrument by a small brass chain, and a slot is cut in the socket of the barrel of the handle where the hole is bored so as to afford space for the insertion of the pin.

This system of pegging over the handle has been in use a great number of years; so long, indeed, that it is surprising it has not ere this been superseded by something less crude and more convenient for working.

The Midland and the London and North-Western have now taken the matter in hand, and are applying as fast as possible the method illustrated below.

A steel pin is fixed in the hole previously provided in the barrel for the reception of the movable pin, and a steel sliding bolt, carried in a small frame fixed to the flange of the socket, takes the place of the metal block with the double inclined plane employed with the peg.

In the illustration H represents the barrel of the instrument handle; I, the socket in which it works; D, the frame in which the slide bolt, C, moves; E, the flange by which the frame of the locking bolt is fixed to the flange of the socket, I; and F the trigger by which the bolt is operated.

The illustration shows the handle free to move in either direction. Assume now that it is desired to lock it in the "line clear" position. The handle is carried over by the hand of the operator to the required position and by the aid of the finger the bolt is shot forward in the direction of E, when it engages with the pin fixed in the barrel in such a manner as to hold the handle firmly in the required position. In order to release the handle it is merely necessary to draw the bolt back again.

As employed on the Midland, the bolt is free to remain in the position in which it is last placed. The London and North-Western so far modify this as to cause a spring to retain it in the locked position. Thus, in operating, it is necessary before the handle can be moved to draw out the bolt.

This improvement provides for a more definite and accurate locking of the handle than was possible under the old pegging arrangement. Moreover, there is with it no possibility, as under the old system was occasionally the case, of the handle becoming so far free as to release the electrical current and so destroy the

signal then being rendered. With the pin and chain and its constant use the woodwork of the instrument became in a very short time greatly disfigured. This is not so with the new lock; the wear and tear is less and the accuracy and facility of working greatly improved.

ON THE TRANSMISSION OF POWER: A REPLY TO M. DEPREZ.*

By M. HIPPOLYTE FONTAINE.

M. DEPREZ has presented some observations on the note of October 26th. These observations, which tend to demonstrate that our experiments present no novelty, either in the methods employed or in the result obtained, may thus be summed up:

1. The process of connecting machines is not novel.
2. The means employed for conducting the rings of the generators much resembles that patented by M. Deprez, April 28th, 1885.
3. Our machines turn too quickly.

Our replies shall be categorical.

1. The method of connecting machines is evidently public property. If MM. Gramme and D' Ivernois patented it in 1872, it was merely that they might not be prevented from using it.

2. The method which we employed for moving the rings of the generators is identically the same as that employed by MM. Chrétien and Félix in their installation for electric ploughing at Sermaize.

3. It is easy to show that there is nothing exaggerated in the speed of our machines, since there now exist more than a thousand Gramme machines which have been working at the same speed for upwards of 10 years without requiring repairs.

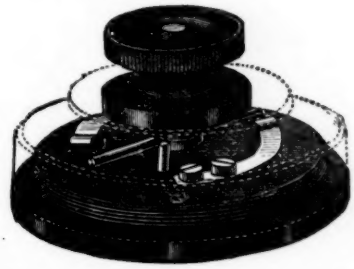
What characterises our recent experiments is not the novelty of the appliances: it is the use of simple dynamos and of well-arranged mechanical elements forming a whole not cumbersome, economic to establish, easy to manage, and, in a word, practical.

The result only appears novel: the transmission of 50 horse-power through a resistance of 100 ohms, with a yield of 52 per cent., whilst employing dynamos which together weigh only 8,400 kilos, and cost only 16,450 francs.

If it is true that in industry we employ by preference a machine of 100 horse-power, working slowly, in place of four 25 horse-power machines, working rapidly, it is especially to secure an economy in fuel. —*Comptes Rendus.*

PREECE AND WILLMOT'S ELECTRIC LIGHT SWITCH.

THE arrangement of this switch is shown by the fig., which represents a general view of the same with the cover removed. It is formed with the usual button or knob of ebonite or other suitable material, and secured to this knob or button is an axle of brass or other metal; this axle passes through a hole in the base and is kept in position by means of a screw and washer, so that the knob and axle can be rotated independently of the base, but cannot be withdrawn from it. Two metal arms, in a line with each other, are fixed at right angles to and on opposite sides of the axle, and turn with it, the angular movement being limited by stop pins. A spiral or rat trap spring has one end fixed to the knob axle and the other end secured to a pin fixed on the base; sufficient tension is given to this spring to draw one of the arms firmly against a stop pin. Two flat metal springs of German silver are secured to the base by means of screws. These springs are of a circular shape, concentric with the knob axle. The ends of these springs are bent to a semi-circular shape, so that they partly embrace the ends of the metal arms, when the latter are turned as far as the second stop pin will allow. The ends of these springs have a downward spring tendency, so that when the arms are turned to the position referred to, these arms become locked, and the tension of the spiral or rat trap spring is unable to draw the arms back to their normal position, unless

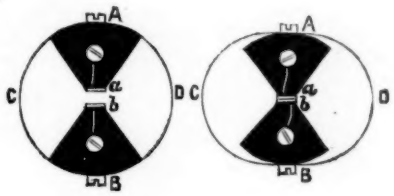


they are forcibly moved from the clutch of the springs by rotating the knob or button. As a certain amount of force is required to disengage the arms from the clutch, at the moment the release is effected the arms disengage themselves with a sudden movement, which causes a disconnection between the arms and springs to be rapidly brought about, so that arcing is prevented. The leading wires to the switch are connected one to each of the two springs.

* See the REVIEW for November 12th, 1886.

BUCKNILL'S CONTACT BREAKER.

THE illustrations show a very ingenious arrangement for making or breaking electrical contacts. We are indebted to *Engineering* for the description. The arrangement consists simply in mounting the contact points within an elastic ring, by distorting which the points may be either separated or brought together, according to the normal condition of the contact. Fig. 1 shows a simple form of the arrangement, in which the points, *a*, *b*, attached to blocks of vulcanite or other



suitable insulating material, are mounted within a steel ring. By compressing this latter in the direction, A, B, or extending it in the direction, C, D, the points, *a*, *b*, are brought in contact, and so maintained until the pressure is removed, when they separate instantly. It is evident that this arrangement is capable of numerous modifications, and that several pairs of contacts can be grouped within the same ring, or if desired they may be fixed so as to act outside. The system is adapted for a great variety of applications, and is now being employed by the War Department and Admiralty, especially for use in land and sea mines. The contacts are manufactured by Messrs. Elliott Brothers.

THE BLACKPOOL ELECTRIC TRAMWAY COMPANY, LIMITED.

IN our last issue we were enabled to give (only briefly as we were just going to press) the result of the year's

working of this company as set forth by the balance sheet, but in this number in its proper place will be found the balance sheet *in extenso*.

At first sight we felt that warm congratulations were due to the inventor of the system and the company using it on seeing that a dividend of 5 per cent. was to be declared whilst £800 was to be carried to depreciation and reserve fund. The satisfaction, however, somewhat changed on glancing through the items of the balance sheet. The receipts, it will be seen, are put down as £5,125 17s. 3d., whilst the expenditure is given as £3,334 14s. 7d., or about 60½ per cent. of the gross recepts, which, as compared with the working of horse tramways, figures very favourably. It is when taking the depreciation into consideration that we do not find that satisfaction which we at first hoped for; the £800, about 5 per cent., to our way of thinking not being at all adequate. The centre channel, it appears, cost £8,354, therefore allowing 10 per cent. for depreciation on this item alone would require £835 instead of £800. The directors, of whom there are ten, have not included any charge for their past services; there is, therefore, this item also to provide for, say ten at £50 each = £500; or taking the whole of the plant, sheds, engines, generators, motors, centre channel and electrical fittings and cars, and allowing 10 per cent. for depreciation and adding thereto £500 for the directors, we find that instead of £800, £2,066 will be required, whilst the disposable balance is only £1,853 10s. 2d. Thus not only could no dividend be paid, but over £200 more should have been earned, it would appear, to provide for the efficient and continuous working and maintenance of the concern. The length of lines worked is but a short one, and it is, of course, a question whether the traffic receipts likely to be earned on such a small concern will pay for ten directors and the great expenses usually attendant on a "limited" company's operations; but leaving the directors' fees out of consideration, there remains the fact that £1,853 is left to be appropriated, and the depreciation fund requires of this (according to our thinking) £1,566, there then remaining £287 to pay the dividend on about £20,000.

There are items to which we would take exception, such as engineer's commission, which seems to be paid on the cost of the work done, and which this year amounts to £541, whilst last year it stood at £400 in that balance sheet; but what we are mainly interested in knowing is, whether the system is or can be made a paying one? It is to be regretted that Dr. Kingsbury, who last year put some pertinent questions to the chairman at the meeting, this year, through his promotion to a directorship, was practically prevented from playing the part of critic at the meeting held on Saturday last.

Considering that there are ten cars in the summer at work and about five in the winter months, the working expenses cannot be thought heavy. Therefore, it seems possible that, if the traffic were equal to the carrying capacity of the cars, the receipts might be very much increased; then, supposing the capital to remain the same, the system might be made to pay very well, and in so far we may congratulate the company in having proved this, although the position is not at present so eminently one for satisfaction as at first it appeared.

[Since the above was written the remuneration of the directors has been fixed at £10 each, but we doubt if such a sum would be generally acceptable, indeed the chairman said at the meeting that, "of course, he would take his share of the money voted to the directors, but he could not devote so much time to the affairs of the company unless he were paid for it."

It appears from the report of the meeting above referred to that the Corporation had an agreement with the company to take over everything at the end of the seventh year, less 2½ per cent., but at what valuation, whether cost or then value, is not stated.—EDS. ELEC. REV.]

REVIEW.

The Management of Accumulators. By Sir DAVID SALOMONS, Bart., M.A., A.I.C.E., M.S.T.E. Baldwin, Tunbridge Wells.

Existing literature on secondary batteries is not by any means in keeping with the times, and the information which one finds in ordinary text-books on electricity is of a most unsatisfactory nature; we therefore welcome anything that may tend to enlighten the public mind in matters concerning the mysteries of accumulators. That accumulators are subject to most mysterious phenomena has been acknowledged by all who have had anything to do with them; but few have had such exceptional opportunities as Sir David Salomons for studying the behaviour of these adjuncts to electric lighting. Opportunities, however, are of no avail if the student is not armed with a large capacity for observation, accompanied by an extensive knowledge of *nature*. Sir David is evidently a most attentive observer, and by the aid of his wide command over physical science he has been able to lift the veil of mystery which surrounded the object of his constant care. He was not satisfied with merely watching attentively certain changes which appeared in the "constitution" of his battery, but he has made numerous experiments in order to arrive at the origin or foundation of various hitherto unexplained appearances; the results of these enquiries are embodied in the twenty pages of a modest pamphlet which has been published for the use of "those who are really in search of practical information," and "whose daily routine deals with electric lighting accompanied by an accumulator." We are not quite so modest as Sir David, and we therefore venture to add that some of the information he gives will also be of use to those whose daily routine it is to manufacture accumulators, and we may even anticipate that the manufacturers will issue this or a similar pamphlet to all users and caretakers of secondary batteries. Modifications in the style and arrangement will no doubt suggest themselves to the initiated reader, and in several ways improvements might be introduced. For instance, the primitive-looking diagram facing the title-page, giving a "general view of connexions in an installation with an accumulator," does not convey a good impression. The cost of a respectable block from a decent drawing would increase the price of the book to probably a shilling, instead of *eight pence*, as it is marked, and this would enhance its intrinsic value considerably. Although we have formed a high estimate as regards the amount of useful information contained in this pamphlet, we cannot invariably compliment Sir David upon lucidity of description.

There is practically no *introduction* to the subject, and though this pamphlet is not intended to be a treatise, yet a concise description of the forms of some well-known accumulators should preface the first paragraph which has the marginal note, "Introduction." This first page is faulty; therein we read:—"All cells may be divided under two classes—the pasted plate cells and the plain lead cells." The word "cells" appears here for the first time, and one would imagine that it refers to receptacles rather than to the plates. Any novice who undertakes the care of an accumulator, with this pamphlet to guide him, may interpret "the plain lead cells" literally as leaden boxes. "In each class," continues the author, "the plates must be 'formed,' and whether pasted or not, they are prepared in numberless ways, each manufacturer claiming his wares as the best." Now, "forming" and "pasting" are manufacturing processes about which the individual in charge of the accumulator may know no more than the fireman knows of the art and science of boiler making. If it is necessary to introduce these expressions, then a short definition ought to precede them, otherwise they only cause confusion. Next follows an anomalism: "The care which should be taken of cells containing formed lead plates is small; but it is a moot point

whether this class is not far inferior to the pasted ones." Just before, the author said that "*in each class the plates must be formed.*" We opine that a lead accumulator is not fit to be put in charge of those for whom the author especially writes, until the plates *are* formed, and when *formed* there is no difference, electrically or chemically, between pasted plates or those which were not pasted, the active materials in both being of precisely the same nature. Mechanically, there is this difference, that the "pasted plates" require some attention, and the rules laid down by Sir David apply to this type particularly.

Here and there we find some cleverly-constructed passages, and these occur in connection with the most difficult parts of the subject, when the author appears to work within his own atmosphere; it is when Sir David attempts to use the simple workshop vocabulary, when trying to drop to the level of the cookery-book language, that he fails and becomes hopelessly obscure. Among the admirable paragraphs is one which explains the cause of "boiling" (visible strong evolution of gas bubbles), page 6: "The reason for this (boiling) is due to the fact that towards the end of the charge most of the active material on the positives has been transformed to a higher oxide, and therefore the active surface of the plates is much reduced; so that clearly the starting charging rate is now too high, and if not reduced the surplus current simply decomposes the liquid, and also makes matters worse by separating the plates from the liquid with a layer of gas bubbles, producing virtually a gas battery with a higher E.M.F."

"Probably, if the charging rate were gradually reduced in proportion to the diminishing surface of the material to be acted upon, boiling would never occur at all, for such a process would last an almost indefinite time; but in practice boiling simply indicates *sufficient* charge for the purpose required, although probably at least double could be given; and if this explanation is right, overcharging in accordance with present ideas can and never does occur, and such a description of the boiling phenomenon is incorrect." What, we may ask, becomes of the gas after the mass contained in the positive plates is completely oxidised? When the charging is continued beyond saturation, at however slow a rate, the gases *must* escape in isolated bubbles, which do not give the appearance of "boiling." The *capacity* of an accumulator depends entirely upon the *mass* of active material, whilst the *rate* of charge depends to a great extent upon the surface exposed to the electrolyte. Sir David evidently does not mean to say that by charging very slowly he can increase the capacity; but we take it that by charging too fast "boiling" begins long before the plates have received all the gas they can hold. The explanations concerning the effects of "bad sulphating" are well rendered, but the main *cause* of "bad sulphating" ought also to have been given; it is of the greatest importance to the well-being of an accumulator to avoid the chances of injurious sulphating, and it can best be avoided by keeping them always well-charged, and especially before any long interval of rest.

The causes of "scaling" and "falling out of active material," together with the remedies, are clearly stated; thus with these, and numerous other useful and sometimes novel suggestions, the user of secondary batteries (of the particular type mentioned) will find much food for reflection; he will no longer regard his accumulator as one of the greatest mysteries; by carefully attending to the instructions given he can entirely prevent failure, and at the same time prolong the life of the plates for a considerable period.

An appendix to the pamphlet contains a description of the accumulator-house at Broomhill, the residence of the author, and therein also will be found a few useful hints, as, for instance, the arrangement of shelves, a novel and ingenious travelling cradle, precautions as regards the influence of the sun upon glass cells, glass covers to prevent loss of liquid, &c. Sir David Salomons deserves the thanks of all interested in accumulators for publishing his experiences.

THE BRITISH ASSOCIATION.

SUR LA CONDUCTIBILITE ELECTRIQUE DES DISSOLUTIONS SALINES TRES ETENDUES.

By M. E. Bouty.* Abstract by Oliver Lodge.

I.—*Historical.*

"The electric conductivity of salts dissolved in water varies with concentration in a manner extremely complex and differing for different salts. One possesses neither general law nor empirical formula, of however limited an application. One conceives *à priori* that this conductivity depends on the chemical nature of the salt, on the hydrates it can form, and on their stability; experience establishes also that it is not without relation to some physical properties of the solution, in particular its viscosity. But the separation of these circumstances has not yet been made. There seemed to me room first to simplify the problem by considering only solutions of identical physical properties. I have therefore chosen solutions so dilute that their density and viscosity are the same as pure water; their conductivity is yet relatively enormous, and can be measured easily by an electrometric method derived from that of M. Lippmann."

In this method, as now applied, the tapping electrodes are zinc in sulphate of zinc, communication being established between the experimental fluid and the sulphate of zinc by a pair of capillary openings in the experimental tube. The difference of potential between these tapping electrodes is either measured by a Lippmann electrometer and compared against another difference taken at the ends of a known wire in the same circuit, chosen so as to be as nearly equal in resistance to the liquid as possible; or, what is plainly better, it is compensated by an auxiliary wire, and the electrometer brought to zero.

The author quotes Kohlrausch's views as expressed in his paper in Wiedemann's *Annalen*, VI., pp. 1, 51, 145, 210; but he objects to them as founded too much on extrapolation, the conclusions being stated for extremely dilute solutions, while those experimented with contained $\frac{1}{2\,0}$th of their weight of salt. "So, although my results present a general agreement with those of M. Kohlrausch within the limits in which he has himself worked, I find myself led for their interpretation to conclusions absolutely different from that of the learned German professor."

II.—*Method of Measurement.*

The liquids to be compared are contained in two long vertical inverted U tubes, dipping with their open ends into two pairs of porous pots, each pair full of the same liquid as is in its tube. The four pots, and also the two main (zinc) electrodes are con-

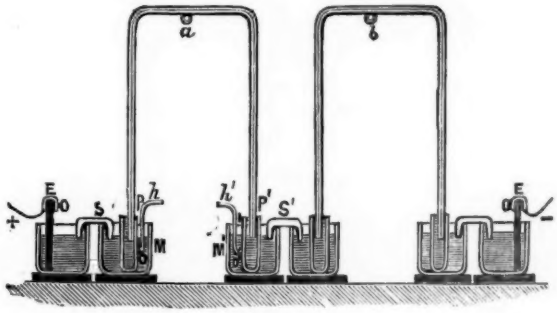


Fig. 1.

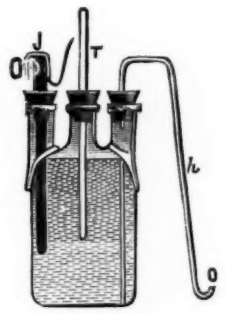


Fig. 2.

tained in six separate glass vessels, all full of sulphate of zinc solution, connected up by short stout siphon tubes, as shown in fig. 1. The tapping electrodes are zinc blocks, each in a Woulffe's

* *Annales de Chimie et de Physique* 6e série, 1884, T. III.; also *Journ. de Phys.*, 2e série, V. III., p. 325. See also Foussereau *Journ. de Phys.*, T. IV.

bottle of sulphate of zinc, with a projecting and recurved full tube able to dip into any part of the liquid in the glass cells outside the porous pots, and so make connection (see fig. 2).

After taking readings for the two tubes filled with different liquids, they are both filled with the same liquid and fresh readings taken, so as to compensate for inequalities between the tubes.

III.—*Conductivity of very dilute Neutral-salt Solutions.*

"When one takes a solution of a neutral salt, already pretty dilute, and doubles the quantity of water it contains, the specific resistance is in general far from being doubled, as one would *à priori* expect; it is multiplied by a coefficient λ, smaller than two, which increases progressively with dilution and tends towards the limit 2, but only for excessive dilution. Here, for example, are some numbers furnished by sulphate of zinc :—

Initial concentration.	*Ratio λ	Initial concentration.	Ratio λ.
$\frac{1}{10}$	1·684	$\frac{1}{100}$	1·752
$\frac{1}{20}$	1·712	$\frac{1}{300}$	1·805
$\frac{1}{40}$	1·721	$\frac{1}{640}$	1·845
$\frac{1}{80}$	1·739	$\frac{1}{1280}$	1·954

"Chloride of potassium gave in one experiment :—

Initial cencentration.	Ratio λ.	Initial concentration.	Ratio λ.
$\frac{1}{20}$	1·921	$\frac{1}{240}$	1·933
$\frac{1}{40}$	1·943	$\frac{1}{480}$	1·958
$\frac{1}{120}$	1·931	$\frac{1}{960}$	1·945

"Anhydrous salts behave in general like KCl, that is to say, the ratio λ is very near 2, even for moderate concentrations. Hydrated salts, on the other hand, are comparable to sulphate of zinc, and it is only for very great dilutions that their ratio λ approaches the value 2."

M. Bouty considers that at sufficient dilution the molecular conductivity of all salts is the same. For salts without water of crystallisation a concentration of $\frac{1}{1000}$ or so may be permitted; but for hydrated salts it is necessary to go below these limits, a thing *which requires the possession of absolutely pure water*, and he is only able to show that they approach equality to the other class of salts when very attenuated. Two tables follow, showing ratios of resistances compared with ratios of concentration, first for anhydrous salts, and then for salts which crystallise with a definite amount of water, KCl being taken as the standard of reference.

IV.—*On the Migration of Ions and its Relation with the Conductivity of Salt Solutions.*

The author styles the case when the migration number of each ion is simply ½ as "normal electrolysis," and he quotes results of Hittorf to show that the salts which thus behave are anhydrous salts, *e.g.*, AmCl, KCy, KCl, K_2SO_4, K_2CrO_4, KNO_3, KBr, $KClO_3$, $KClO_4$, Ag_2SO_4, KI, $AgNO_3$.

For all these Hittorf's number (n) is very near ·5, and scarcely varies with dilution. But for salts which definitely combine with water neither of these statements hold. Here are Hittorf's numbers. S represents the weight of water combined with 1 gramme of the salt; n expresses the loss of concentration at the cathode while 1 equivalent of electrolyte is decomposed.

Salt.	S	n	Salt.	S	n
$CaCl_2$	1·6974	·780	$BaCl_2 + 2H_2O$...	3·5	·662
	2·0683	·771		8·4	·642
	2·3608	·765		100	·614
	2·739	·749			
	3·9494	·727	$MgSO_4 + 7H_2O$..	5·3	·762
	20·918	·683		309·6	·656
	138·26	·673			
	229·2	·683	$CuSo_4 + 5H_2O$...	6·35	·724
				9·56	·712
$MnCl_2 + 4H_2O$...	3·306	·758		18·08	·675
	190·41	·682		39·67, 148·3	·645
$MgCl_2 + 0H_2O$...	2·48	·806	$ZNSO_4 + 7H_2O$..	2·524	·778
	3·7	·778		4·052	·760
	22·2	·706		267·16	·636
	128·3	·677	$Na_2SO_4 + 10H_2O$	11·77	·641
	241·3	·678		50·65	·634

* This "ratio λ" is plainly the same thing as Arrhenius's "exponent of dilution," only more simply introduced. I have shown in remarks on Arrhenius's memoir (first part) that the meaning of this "ratio λ," in so far as it is constant, is that conductivity varies as a power of the concentration, kam^r where $r = \log \lambda / \log 2$.

It seems from this table that hydrated salts approach normality as their solutions become very dilute. They then also tend to obey the law of equivalents (k/m = const.); so the two things are connected.

"When a salt obeys the law of equivalents, its electrolysis is normal (migration number ½); when it does not obey it is abnormal, and the divergence which the law presents to the law of equivalents is so much the greater as the number n differs more from the normal value ·5. . . . There is thus, between the resistance of salt solutions and the phenomenon of migration, a very close relation, impossible to overlook."

A still more striking proof of this relation is afforded by some salts of which the electrolysis is not normal and does not tend to become so with increasing dilution. For instance nitrate of soda :—

	S.	n.
$NaNO_3$	2·066	·588
	2·994	·600
	34·76	·614
	128·7	·614

[The meaning of n = ·614 is that when an equivalent of $NaNO_3$ is decomposed, ·614 of an equivalent is lost from neighbourhood of cathode and ·386 from neighbourhood of anode.]

The number n thus varies little with dilution, and appears rather to diverge from the normal value ·5 as dilution increases.

A comparison between $NaNO_3$ and KCl of the same concentration has furnished me with the following results :—

Concentration.	Ratio of resist.	Ratio of equivalents.
$\frac{1}{2000}$	1·489	1·141
$\frac{1}{1000}$	1·476	

The specific resistance thus scarcely varies with dilution, and it is almost 1·3 time its theoretical value. The permanent anomaly of its electrolysis corresponds to a permanent disobedience of the law of equivalents. Salts which behave something like nitrate of soda are LiCl, NaCl, $CaSO_4$, $NaNO_3$, $NoClO_3$, $Ba2NO_3$, CaI, $Ba2ClO_3$; $Li_2SO_4 + H_2O$, $Ca2NO_3 + 4H_2O$, $SrCl_2 + 6H_2O$, NaI + $2H_2O$.

V.—*Discussion of the Results of M. Kohlrausch.*

Kohlrausch attributes to every ion a specific molecular conductivity which it preserves in every combination.

Bouty asserts that the molecular conductivity of all neutral salts in every dilute solution is the same, and would thus consider that all the numbers of ionic velocity given by Kohlrausch should be all equal, which they by no means are.

He proceeds to criticise Kohlrausch's experiments by saying that the solutions he used were too concentrated, the weakest containing 5 per cent. of salt, while Bouty's went as low as ·025 per cent.

On the other hand Kohlrausch's tables are too comprehensive; they include, first, acids and taric hydrates; second, salts decomposed by water, double salts, &c.; third, neutral salts, which remain abnormal even in very dilute solution, or "abnormal salts."

The class of bodies most favourable to M. Kohlrausch's results are those relating to anhydrous and nearly "normal" salts. Here are his numbers for the following ions. The numbers for Am, K, Cy, Cl, Br, I, and NO_3 differ very little from a mean value 50. But for Ag, SO_4, ClO_3 the atomic conductivity is 40, and for CO_3 it is 36.

"To compare these numbers with my own, this is what I have done. Consider, for example, K_2SO_4; its molecular resistance according to Kohlrausch is

$$\frac{1}{48} + \frac{1}{40} = \frac{88}{1920}.$$

That of KCl, which I have used as a standard, is

$$\frac{1}{48} + \frac{1}{49} = \frac{97}{2352}.$$

The ratio of these is 1·1114.*

I have measured this same ratio at different concentrations—viz., $\frac{1}{20}$, $\frac{1}{200}$, $\frac{1}{1000}$, $\frac{1}{4000}$, and find numbers which, divided by the ratio of equivalents, give respectively

1·288 1·144 1·074 1·011.

These evidently tend toward the limit 1, and not to the number 1·1114 proposed by M. Kohlrausch.

Similarly with K_2CO_3 and $AgNO_3$.

For sulphate of silver compared with KCl, Kohlrausch's table would give 1·21, which I find by experiment ·981.

These divergencies are not enormous, but they get much bigger if one proceeds to study normal hydrated salts whose conductivity varies so rapidly with dilution.

* This is a mistake. The velocity numbers themselves must be added, not their reciprocals; so for K_2SO_4 48 + 40 = 88 is the conductivity, and for KCl it is 97; hence the ratio is 1·10. The difference being so small I have left the figures of M. Bouty unchanged, especially as the ground of his arguments is only partially affected, not removed. In a note to the September, 1886, *Journal de Physique*, p. 428, M. Bouty admits his slip.

Kohlrausch's numbers for the following metals are very different from 50 :—

Ca 26
Ba 29
Cu 29 and 12
Mg 23 and 14
Zn — and 12

When two coefficients are given, the former belongs to ordinary salts, the other to sulphates, which otherwise M. Kohlrausch cannot get to obey his law.

Comparing these with KCl in the manner already explained, M. Bouty gets the following table, in which Kohlrausch's numbers are also inserted for comparison :—

Concentration.	$\frac{1}{20}$	$\frac{1}{200}$	$\frac{1}{1000}$	$\frac{1}{3000}$	Limit according to Kohlrausch.	
					As given by Bouty.	Corrected by O. L.
$CaCl_2$	1·437	1·339	1·251	1·181	1·428	1·29
$MgCl_2 + 6H_2O$...	1·339	1·277	1·131	1·029	1·549	1·34
$BaCl_2 + 2H_2O$ ...	1·290	1·133	1·081	·951	1·331	1·24
$Mg2NO_3 + 6H_2O$	—	1·323	1·249	1·163	1·581	1·4
$Cu2NO_3 + 6H_2O$	1·474	1·281	1·253	1·135	1·363	1·29
$MgSO_4 + 7H_2O$	2·777	1·879	—	1·249	2·834	1·80
$CuSO_4 + 5H_2O$	3·130	2·272	1·591	1·310	3·123	1·86
$ZnSO_4 + 7H_2O$...	2·924	1·923	—	1·220	3·123	1·86

"It suffices to read the numbers in any horizontal row to see that they tend towards the limit 1, not towards variable limits according to the nature of the salt. The ratios deduced from the table of Kohlrausch agree very nearly with the numbers in my first column for concentration $\frac{1}{10}$." Polarisation is so strong at the contact of metals with salts of Mg and Al that perhaps polarisation was not altogether avoided by Kohlrausch for the case of the magnesium salts above.

"To sum up: Molecular conductivities tend visibly to equality for hydrated as well as for anhydrous salts, and the disagreement of my results with those of Kohlrausch finds itself explained in the most satisfactory manner."

VI.—*Application of Faraday's Law to the Study of the Conductivity of Salt Solutions.*

"The law which I have just announced may be extended to a variety of salts. It suffices to know the manner in which the salt is electrolysed, and what quantity of salt is equivalent to KCl, for the application of Faraday's law."

The author then gives figures for various salts, classifying them thus :—

a. Salts with several equivalents of acid.
b. Double salts decomposed by water (including alums).
c. Simple salts decomposed by water (tin salts and Fe_2Cl_6).
d. Stable double normal salts (K_4FeCy_6, &c.).
e. Double abnormal salts.
f. Phosphates and arseniates.
g. Bicarbonates.
h. Mercuric salts.
i. Tartar emetic and a couple of cobalt compounds.

He finds that $HgCl_2$, $HgBr_2$, and $HgCy_2$ are unique; they are insulators. Water containing five grammes of one of these substances to the litre conducts very little better than pure water: 200 times less than what the k/m law would give. Sal alembroth, however, conducts.

VII.—*Organic Substances.*

Organic salts differ in no essential character from salts of which the acid and base are mineral. If the electrolysis is normal the law of equivalents rigorously applies, otherwise it does not just as with mineral sorts.

Bodies like alcohol, glycerine, glucose, urca, &c., are very bad conductors, and it is difficult to make sure that the feeble conductivity they show (when commercially pure) is not due to the presence of traces of salt.

VIII.—*Conductivity of very dilute Acids and Bases.*

The author has been led to the following conclusions :—

"*Acids and bases which dissolve in water without combining with it furnish insulating solutions; on the other hand, when these substances combine with water in a manner more or less complete they conduct in the same way as salts.*

"But a given acid or a given base often forms with water several different combinations. These combinations are usually unstable in presence of excess of water; they are dissociated more or less by elevation of temperature and by dilution. It is only in a manner altogether exceptional that a monobasic acid can exist in dilute solutions in the monohydrated state, and without mixture with superior hydrates. Its mode of electrolysis and its conductivity will vary in a corresponding manner. It is therefore not legitimate to liken acids and bases in aqueous solution to neutral salts. The law of equivalents cannot be directly applied to them."

Then follows a twelve page discussion of results to establish these laws. From this I make a few extracts only.

The case of sulphuric acid is interesting, since it can crystallise with either one, two or four, molecules of water, and it undergoes maximum contraction when combined with six atoms. It is known also to possess a maximum conductivity for sp. gr. 1·25. M. Bouty finds that the ratio λ attains a minimum for a concentration about 1/500, as the following table shows :—

Initial concentration	$\frac{1}{50}$	$\frac{1}{80}$	$\frac{1}{120}$	$\frac{1}{240}$	$\frac{1}{480}$	$\frac{1}{960}$	$\frac{1}{1920}$	$\frac{1}{3840}$	$\frac{1}{7680}$
λ	...	...	1·917	1·894	1·867	1·856	1·849	1·854	1·881	1·942	2·002

"One does not see how to explain a variation of this kind except by a change in the nature of the electrolyte (*i.e.*, of the dissolved hydrate)."

By making the hypothesis, which Bourgoin made, that the hydrate really decomposed by the current was S_2O_6, $6H_2O$, M. Bouty considers that the anomaly of electrolysis as expressed by Hittorf's values of n, and also that of conductivity, is explained. These are Hittorf's values of n for dilute sulphuric acid. Hydrochloric acid is in much the same condition as sulphuric acid.

* S =	·5574	1·4383	5·415	23·358	97·16	161·4
n =	·400	·288	·174	·177	·212	·206

It conducts as if its molecule contained three equivalents of basic hydrogen. One does not know such a hydrate, but there is probably a mixture of hydrates present.

Oxalic and picric acids are the best conducting organic acids. Other acids conduct hardly at all when strong, and dilution has an enormous effect upon them—probably because they combine with water forming compounds analogous to salts.

IX.—*Influence of Temperature.*

To study this, the U tubes of fig. 1 are turned upside down and immersed in a bath. The result is that for normal neutral salts the conductivity is a linear function of temperature.

$$k = k_0 (1 + bt),$$

where b is the same constant for all the salts, and equal to about ·0337. This agrees with Kohlrausch also.

It is noteworthy that Poiseuille gives the quantity of water which flows through a capillary tube, under a given pressure, as proportional to—

$$1 + ·03365t + ·00021t^2.$$

It is impossible not to be struck with the identity of the principal co-efficient in this formula, with b in the conductivity formula; showing that resistance is of the nature of a friction, as Wiedemann surmised.

For abnormal salts the co-efficient, b, is a little greater, and a parabolic formula is required at higher temperatures. So, although these salts conduct worse than normal ones to begin with, they improve faster when heated, and accordingly their abnormality decreases with rise of temperature.

For acids and bases the temperature co-efficient is rather less, being only ·0119 for sulphuric acid, and ·024 for hydrochloric. Probably warming breaks up some good conducting hydrate, and so spoils conductivity almost as fast as it otherwise improves it.

"To sum up: I believe I have established that the electrolysis of neutral salts is a simple phenomenon, and that there is only one elementary law of conductivity in harmony with the law of electro-chemical equivalents. Apparent exceptions only reveal to us the complexity of certain solutions which are not directly comparable with those of KCl or K_2SO_4."

ON THE EMPLOYMENT OF ALTERNATING CURRENTS FOR MEASURING LIQUID RESISTANCES.†

By MM. BOUTY AND FOUSSEREAU.

THE authors criticise the employment of alternating currents employed by Kohlrausch and many others in the hope of diminishing the effect of polarisation. They point out that self-induction in the resistance box is fatal to silence in the telephone [naturally], and only succeeded in getting good results when they replace wire in their bridge by liquid resistances, describing for this purpose a liquid rheostat. Even thus, however, they hardly get concordant results when they try to apply the method to extremely weak solutions.

ON MECHANICAL AND THERMAL EFFECTS ACCOMPANYING ELECTROLYSIS.‡

By M. BOUTY.

A SERIES of short memoirs have been published by M. Bouty in the *Journal de Physique* on a branch of the subject not very immediately connected with that which at present concerns us. I had occasion to refer to part of them in a communication on the seat

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* S means the weight of water combined with one gramme of acid.

† *Journal de Physique*, 2e ser, September, 1885, T. IV.

‡ Brief abstract, by Oliver Lodge.

of E.M.F. in the voltaic pile. (*See* "B.A. Report," 1884, pp. 492 and 513, or *Phil. Mag.*, Vol. XIX., 1885, pp. 189 and 343 to 350.)

The references to them are as follows:—

1. *On some mechanical and thermal effects accompanying electrolysis* (*Journal de Physique*, 1879, T. VIII., pp. 289 and 341).

2. *Thermo-electric and electro-thermic phenomena at contact of metal and liquid* (1880, T. IX., p. 306).

3. *On the contraction of galvanic deposits, and its relation with the Peltier phenomenon* (1881, T. X.)

In the first of these papers metals are deposited on silvered thermometer bulbs, and the mechanical compression of the different deposits studied, Wertheim's results in elasticity being applied to them.

The effect of heat on such metallised thermometers is also discussed.

Metallised thermometers are then used as electrodes to examine the changes of temperature which occur while various ions are being liberated. During the electrolysis of $CuSO_4$ or $ZnSO_4$, the anode is slightly warmed, the cathode slightly cooled; inverting the current cools the new cathode distinctly. Electrolysing dilute H_2SO_4 with platinum coated thermometers, the anode is quite warm, the cathode scarcely at all. This is the permanent effect. Inverting the current cools the old anode, sometimes $\frac{1}{2}$ degree below the temperature of the surrounding liquid. The effect can be repeated seven or eight times, although with decreasing intensity, if one takes care to stir the liquid between the inversions.

Replacing H_2SO_4 by HCl the permanent effect is very small, but both poles heat strongly at each inversion. With $PtCl_4$ one observes at each inversion a cooling of the old anode and a heating of the old cathode. In every case examined anode is hotter than cathode in the permanent state.

In the second paper, metal liquid junctions are warmed and cooled alternately, so as to give thermo-electric currents, the E.M.F. of several circuits being measured. An attempt is then made to measure absolutely the coefficient of the Peltier effect at these junctions when a current passes, a method suggested by Maxwell ("El. Electricity," p. 146) being used. The result is that the author believes the effects to be purely physical, without known relation to the heats of combination or the latent heats of solution, but connected exactly with the thermo-electric forces of couples corresponding. The thermo-electric laws of Sir W. Thomson are believed to apply without modification. Chemical effects are regarded as disturbances producing parasitic heats.

In the third paper, the author reconsiders the contraction of galvanic deposits in the light of the Peltier effect, and comes to the simple and satisfactory conclusion that the two phenomena are immediately connected. Each envelope being deposited at a rather higher temperature than it is able afterwards to maintain, a state of compression naturally results. This view he sustains by experiment.

A WILD SCHEME.

(*From the "Railway News."*)

THE present would not appear to be a very opportune moment to ask for a million of capital to lay yet another cable across the Atlantic. The Anglo-American and its allies, owning eight cables, are unable to pay any dividend, and their rivals, owning two lines, are in about the same unpleasant position. Such, however, appears to be the faith of certain promoters of companies in the gullibility of the British investor that a proposal—we cannot believe it to be a serious one—is made for laying yet another independent, and presumably non-dividend paying, cable to connect the old and the new world. The scheme now proposed is identical with one which was started some 30 years since, and at a time when the practicability of ocean telegraphy had just been demonstrated by the short-lived cable of 1858. The subject of ocean telegraphy at that time excited much public interest, and the Governments of varies countries were solicited to give substantial support, in the shape of guarantees or subsidies, to the carrying out of the great work. Among others the Emperor Napoleon evinced a lively interest in the subject, and as the result of various interviews of promoters with members of the French Ministry, a concession was granted to a body of more or less influential English capitalists, giving permission to lay a cable from Bordeaux to Cape Finisterre, in Spain. Thence the cable, by the permission of the Spanish and Portuguese Governments, was to be laid to Lisbon and the Azores, and thence to cross the Atlantic, finding its last resting-place at Cape Cod, or on one of the French islands off Newfoundland. All attempts to induce his Majesty to give a guarantee or subsidy for the undertaking were unavailing, and even M. Fould, M. Magne, M. de Morny, and other members of the Government could not be brought to see their way to incurring such a liability; though they had a tolerable keen perception that in some form or other the promoters or the contractors, jointly or severally, ought not to be unmindful of their assistance, nor ungrateful for what they considered a very valuable boon—viz., that of permission to spend a million of money in attempting to solve the question of ocean telegraphy, and to lay one end of their cable upon French territory. The interruption of communication through the first cable weakened the confidence of the public in this new description of enterprise, and the appeal to the public for the required million produced no corresponding results. The support given to the scheme by Sir Joseph Paxton, Sir James Duke, Mr. Wyld, and others was unavailing. The confidence of the investing public, both in England and France, in the success of the proposed European and American Submarine Telegraph was finally crushed by the publication of a chart showing the deep-sea soundings of the various portions of the Atlantic. The section between Iceland and Newfoundland was shown as an easy and gentle curve gradually sloping towards the lowest depth of something like two miles, admirably adapted for receiving the cable. It was described, in fact, as the "Telegraph Plateau," and there were some persons who, claiming to possess peculiar sources of information, declared that "providence" had specially created this portion of the Atlantic for the purpose of connecting the old and new world by telegraph, just as in later times Sir Edward Watkin had declared that the grey chalk stratification beneath the Straits of Dover had been reserved by the Creator for the purpose of connecting England with the Continent by means of his Channel Tunnel. The profile of the ocean laid between Portugal and America by way of the Azores, exhibited a very remarkable contrast to this. All those Atlantic islands lying off Portugal are of volcanic origin, and about this time some disturbances, due to earthquakes or other causes, had attracted considerable attention. One of the rocky islets had disappeared, and a new one had made its appearance in the small archipelago. The soundings for more than 600 miles were represented by a series of huge sharp-pointed rocks rising up from the bed of the Atlantic, like the diagrams which illustrate the fluctuations in prices of some active speculative stocks, with which most of our readers may be familiar. Between these volcanic upheavings were precipices varying from hundreds to thousands of fathoms in depth, and any cable to be laid in this region would have to rest upon the heads of these submarine rocks, and stretch for many leagues over the vast depths beneath, with no intermediate support. The heads of these submarine mountains also, it was reported, had an inconvenient habit of constantly changing, from the operation of sub-aqueous causes alike unknown and uncontrollable. Scientific men and experienced naval officers declared that no cable of a strength sufficient to bear the strain of these stretches could be manufactured, or laid, with even the remotest chance of success. Raise Ben Nevis and Snowdon to some five times their present altitude, submerge their summits in 10 or 100 fathoms, fill the intervening valley between them with the storm-tossed waters of the Atlantic, strew the bottom of this sea with more or less active mud and other volcanoes, stretch from the tops of the Scotch and Welsh mountains a cable of less than an inch in diameter, and some idea may be formed of the physical difficulties which nature had interposed in the way of laying and maintaining a cable in the region of the Azores. Contractors and inventors of new and improved forms of light and heavy cables were, however, prepared to do all that was necessary to carry out the hopeless enterprise, if only the public would provide the necessary capital. This they then declined to do, and until the past week no attempt to revive the cable by way of the Azores and the "much-vexed Bermoothes" has been made. A generation has passed away since the route was first proposed, but the practical difficulties in the way of carrying out the work are all unchanged and unchangeable. Now, however, when 10 cables cross the Atlantic, and £6,000,000 of the money invested in them are receiving no dividend, the project has been revived, but not a word is mentioned of the natural and physical difficulties which it would have to encounter, and which cannot possibly be overcome. The financial results of the scheme, and the chances of obtaining the capital required, are so remote that they are practically, and for all useful purposes, as much beyond the sphere of rational discussion as would be a proposal to construct a telegraph from the earth to the moon.

[We have taken the foregoing from the *Financial News* of Monday last. The article looks like a reawakening of a very old story which was quite the correct thing to say in submarine cable circles during the early struggles of transatlantic telegraphy some 30 years ago. At that early period the total number of soundings over the Atlantic bed amounted probably to 50 or 60, and therefore the conclusions drawn by the writer of that day were on the slightest of data, imagination and self interest serving in the stead of knowledge. From to-day's standpoint it seems ridiculous that human beings can be found to believe that one sounding on an average in a square superficies of 40 miles in each direction can justify the sweeping assertions found in such documents as that above quoted. The ignorance on this subject of 30 years ago can only be repeated to-day with intent to deceive, and should be branded as a wilful deception. Readers of our remarks must not think we are writing in support of the "International Cable Company." Far from this, we consider the scheme ruined by financial arrangements, such as a sub-contract for £122,800 for commissions, &c., and another allowing £25,000 as payment for securing the caution money deposited in Lisbon, the amount of this caution money being £10,000. In fairness to the company, it must be stated that these contracts are fully declared by the directors, and were open for the inspection of intending subscribers. We mention these facts to clear ourselves from the charge of favouring the new scheme. The principal objects of our remarks and the reprint of the above article is to controvert the public statements which the present knowledge of ocean beds enables us to state are untrue. From an historical point of view the article has its merits.—EDS. ELEC. REV.]

LEGAL.

The Anglo-American Brush Electric Light Corporation v. Crompton & Co.—(Before Lords Justices Cotton and Bowen, on Tuesday.)—This was an appeal by the defendants from an order of Vice-Chancellor Bacon that the defendants should deliver further and better particulars of objection showing how and in what respect the alleged invention described in the final and amended specification referred to in the statement of defence and particulars of objection delivered by the defendants in this action was a different invention from that described in the provisional specification. The action was brought in respect of an alleged infringement of a patent (as amended by a memorandum of alteration and disclaimer) for an invention of "improvements in apparatus for the generation and application of electricity for lighting, plating, and other purposes." The defendants, besides denying infringement by their particulars of objection, relied on the following objections to the validity of the patent:—The patentee under whom the plaintiffs claimed by assignment was not the true or first inventor; want of novelty and utility; that the specification as amended did not sufficiently describe and ascertain the alleged invention, and in what manner the same was to be performed, and did not sufficiently distinguish which of the matters and things therein described the patentee claimed and which he did not claim to have invented, and that in other respects the specification as amended was insufficient, ambiguous, and misleading; that the alleged invention described in the complete specification as amended was a different invention from that described in the provisional specification. The particulars delivered by the defendants also objected that the specification as amended did not show any means whereby the alleged invention claimed by the seventh claiming clause of the invention as amended by disclaimer could be carried out. Instances of prior publication within the realm of the alleged invention were stated. Mr. J. G. Butcher, in support of the appeal, contended that the particulars of objection as delivered by the defendants were sufficient and sufficiently apprised the plaintiffs of the nature of the question of law raised against them. No doubt it might be convenient for the plaintiffs and to their advantage that they should know the precise line of argument that would be adopted, but so long as a plaintiff was not taken by surprise it was not intended by the Legislature, either under the former or under the new Patent Act, that the defendant should be compelled to argue his case in the statement of objections which he delivered in compliance with the statute. Mr. J. G. Graham, for the plaintiff corporation, was not called on. Lord Justice Cotton was of opinion that the Court could not interfere with the order made by the Vice-Chancellor. With regard to the nature of the particular claim referred to, he had not had at present sufficient opportunity of studying the specification in order to enable him fully to determine what the objection really was. But it was clear that a defendant who delivered particulars of objection was bound to give such information and so to describe the object and scope of the objection as to tell the plaintiff what was the nature of the case he had to meet. In this case it was only reasonable that further and better particulars of objection should be delivered, not as heads of argument, but to enable the plaintiff to be prepared for the case raised by the defendant. Lord Justice Bowen concurred. Mr. Graham asked for the costs of the appeal. Mr. Butcher submitted that it was a new point which had not arisen since the Act of 1883 came into operation. Lord Justice Cotton: We have so many new points brought before us that we cannot make any distinction. The appeal will be dismissed with costs.

Gilman v. The Gülcher Electric Light Company.—Court of Appeal, November 27th, before the Master of the Rolls and Lords Justices Lindley and Lopes. This was an action by the plaintiff to recover £256 5s. for fees alleged to be due to him as a director of the defendant company from April 1st, 1884, to May 14th, 1885. The defendants counter-claimed for calls due on certain shares in the company standing in the plaintiff's name. Mr. Justice Grantham, before whom the case was tried, held that the plaintiff was not entitled to any fees from January 1st to May 14th, 1885, and gave judgment for the defendant company for a balance due in their favour of £29, after giving the plaintiff credit for his fees up to December 31st, 1884. The plaintiff appealed, and Mr. Candy, Q.C., for him, contended that as the plaintiff had joined the board when the £1,500 was divided in certain specified shares, the directors had no right after the plaintiff had resigned to alter that mode of division as regards the past so as to deprive the plaintiff of his fees. Mr. L. E. Pyke, for the defendant company, was not called upon to argue. The Court dismissed the Appeal. The Master of the Rolls said that the learned Judge had adopted the true construction of article 52. The plaintiff's remuneration depended upon that article. The company undertook to pay £1,500 per annum to the directors, but no time in the year was mentioned to show when that sum was to be paid; therefore the company might pay it at any time during the year. Nor was there any limitation of time as to when the directors were to determine on the mode of dividing the money. If the directors came to no resolution, the money would be divided according to the attendances. Therefore a director who did not attend at all would get nothing. The article was wide enough to give the board power to come to the determination which they did in this case, and the resolution was not *ultra vires* because the plaintiff had ceased to be a director and because the resolution dealt with the past. It was said to be a gross injustice on the plaintiff, but there was nothing to show that. The directors would probably say that they had reason for what they did; and as the plaintiff, in fact, did not attend the meetings, there did not seem to be anything unjust in it. At any rate it was immaterial, as the 52nd article gave the directors the power to pass the resolution of May 28th. The Lords Justices concurred.

NOTES.

Proposed Electric Lighting of Portsmouth Dockyard.—The civil authorities at Portsmouth have, it is reported, made strong representations to the Board of Admiralty regarding the desirability of lighting the dockyard by means of electricity, and there are reasons for believing that "my Lords" are inclined to take the matter into their favourable consideration. At present a few oil lamps afford quite inadequate illumination, so that after dusk darkness almost reigns supreme. Already, whenever there has been a particular pressure of work, the workshops have been lighted by electricity to enable the men to work at night.

Extension of Electric Light.—Messrs. Harrison, Ainslie & Co., have extended the Jablochkoff system in their iron mines, Lindal Moor, the circuits now covering four miles. Lindal Church is also lighted through the agency of accumulators, and the company's extensive workshops and stores are now fitted with incandescent lamps. This extension arises from the satisfaction which the Jablochkoff lights have given for a long time past, the exposed position of the mines rendering it essential that a system which should not easily be affected by rough usage should be employed.

Electric Lighting of Steamers.—The Tay Ferries Trustees have just completed the fitting up of the electric light on board their steamer *Dundee* by way of experiment, and should it be successful the light will also be provided on board the other ferry steamers. The *Dundee* is fitted with 22 incandescent lamps of 20 candle-power each, and an arc lamp of 1,000 candle-power. The work has been satisfactorily executed by Messrs. J. D. F. Andrews & Co., Glasgow. The same firm has arranged to fit the electric light on the Granton and Burntisland ferry steamers.

The Lighting of Underground Railways.—For some time back the question of the lighting of the tunnel of the Underground Railway at Glasgow has occupied the attention of the directors of the North British Railway, and various modes of solving the difficulty have been suggested to them. A highly interesting experiment with the method which has found most favour with the management was made last week. This is termed the "Improved System of Electrical Train Lighting," and is the invention of Mr. Thomas P. Carswell, of the engineers department of the North British Railway. There is a central rail, along which the current is sent, raised a little above the level of the permanent rails, while on each of the carriages are contact pulleys which, coming in touch with this middle rail, convey the current to the incandescent lamps fitted up throughout the train. An electric rail has been laid from Queen Street to College, and on this a long and complete train of first and third class carriages which have been furnished with the necessary apparatus was subjected to test. The experiment was highly successful. The train was run backward and forward between the two stations, and as each of the carriages emerged from the tunnel at the College end, the lights went out in regular succession, while, when the tunnel was re-entered, each carriage again in regular succession brilliantly lighted up as contact was made between the pulleys and the middle rail. It is expected that a train—probably an Airdrie and Hyndlands one—with the new system of lighting will be put on for the public service this week.

Central Station Lighting in Sheffield.—An electric light supply station, on a scale not hitherto attempted by private enterprise, has just been completed by Messrs. Tasker, Sons & Co., electrical engineers, with the object of supplying light to public buildings, hotels, shops, works, &c., in any part of Sheffield. The station, which is enclosed within substantial buildings is in Commercial Street. Preparations have been made for considerable future development. There has been fixed a compound condensing engine of 200 indicated horse-power, either side of which is arranged to work the electric light machinery in case of accident to the other, and in order to avoid any stoppage in the supply of light. Supplying this engine with steam is a large Galloway boiler, fitted with Proctor's mechanical stoker and other improvements. The fly-wheel of the engine works on to counter shafting, and from this the power for the dynamos is taken. At present in the dynamo room is fixed a Thomson-Houston 45-light machine and one Siemens shunt-wound machine, which latter will be employed to charge secondary batteries for incandescent lighting. It is proposed to rent out lights to consumers for an annual sum per lamp, which will include maintenance and attention, thus relieving customers from all trouble in this respect, and already a very encouraging start has been made in the supply of lights to various consumers.

Electric Lighting at the Newcastle Exhibition.—The exhibition buildings and grounds have been divided for lighting purposes into nine sections, and contractors were invited to tender for any one section or for more than one or for all. The number of lamps at present requisitioned is modestly put at 139 arcs and 1,040 incandescents, but as these numbers are only about half what were put up at the Edinburgh and Liverpool Exhibitions, there is every probability the number actually needed will be much larger. The required engine power will be provided by the executive. The latest day for tendering was yesterday.

Southampton Telephone Exchange.—This exchange, which was established some six months since by the Western Counties and South Wales Telephone Company, is gradually developing into a flourishing concern. Forty subscribers have already been connected, and it is announced that when the half-century is reached the company will concede day and night service (Sundays excepted) without extra charge. The present rentals are, for any distance within a one mile radius of the Bargate, £12 one year, £11 four years, £10 seven years.

Tragic Telephone Incident.—In Brussels recently a young lady, who had mistaken the civilities of a young man for intentions of a more serious nature, hearing that he was engaged to one of her friends, placed herself in communication with him by means of the telephone, and put to him the direct query: "Are you going to marry Mdlle. ——?" The young man replied that such was his intention. "Then good-bye for ever" were the next words which reached his ears, and they were followed by he report of a firearm. The young lady had lodged evolver bullet in her heart.

American Telephone Patents.—A suit for the cancellation of the Bell telephone patents was recently brought by the United States before an Ohio Circuit Court, in the city of Columbus. Much was hoped for from this action, but it has received one defeat already, the *Scientific American* states. The question of jurisdiction by a circuit court over a company not in its district was raised. It was decided that the Bell Company, being a Massachusetts corporation, was outside of the jurisdiction of an Ohio Court. The decision was given without prejudice, leaving it open for the plaintiffs to bring suit elsewhere.

Preston Telephonic Exchange.—This exchange, which was opened on September 1st, 1881, has been amalgamated with that of the Lancashire and Cheshire Company. By this amalgamation the company ceases to have any opposition in the district. The Preston public hitherto have been able to boast of having the lowest rate of telephone subscription of any town in England and two separate telephonic exchanges. Preston has a population of about 100,000 inhabitants, and now has one of the strongest exchanges in England, with between 400 and 500 subscribers. Day and night service and trunk wires connect most of the business towns of Lancashire, and also the popular seaside resorts of Blackpool, Lytham, St. Anne's, and Fleetwood. We are informed that it is shortly the intention of the Lancashire and Cheshire Company to allow subscribers to the Preston centre to communicate with the Lancashire seaside resorts without extra charge; this will be a very great boon, and will do much to popularise the system. The subscription, which hitherto has been from £6 to £8 per year, has, of course, to be increased. This is the natural outcome of a monopoly, but the Preston public can well afford to pay the higher rates, as owing to Mr. Sharples's opposition, for the first three years nearly all had their connections free. The company has not purchased Mr. Sharples's telephone instruments; these are offered for immediate sale outside the company's district. Mr. Sharples, who was one of the first to introduce the telephone into the North of England for business purposes, has always been a strong opponent of the telephone monopoly, selling instruments outright to the public, having purchased a large number when the policy of the holders of the patent was to sell in a sensible way. This amalgamation will liberate a large number of instruments for private line work.

Post Office Telegraphists.—At a meeting of Post Office telegraphists held in Liverpool on Saturday evening last, great satisfaction was expressed at the appointment of a Royal Commission to inquire into the working of the Civil Service. Discontent and agitation had, it was stated, been rife in the telegraph service ever since its transfer to the State, and the staff were determined that, so far as their department was concerned, no effort on their part should be spared to enable the inquiry of the Commission to be searching and thorough. Resolutions were unanimously passed condemning in strong terms the present system of promotion by selection as giving opportunity for favouritism and injustice, and an earnest hope was expressed that the commission would not only recommend a more equitable system, but make close inquiry into the fairness of past promotions, and into the mode of exercising those absolute powers in this and other directions which the surveyors practically possess. A committee was then appointed to prepare and lay before the surveyor of the district a statement of the information wanted.

Telegraph Revenue.—The receipts on the telegraph service from April 1st to November 27th, 1886, amounted to £1,235,000 against £1,210,000 received from April 1st to November 28th, 1885.

The "Monarch."—The Post Office cable ship Monarch arrived in Burntisland roadstead on Monday for the purpose of repairing the damaged cable between Granton and Burntisland.

The International Cable.—Mr. Thomas Kent, writing to the *Times*, from the Devonshire Club, says:—"It is unusual, indeed almost unfair, of the managers and secretaries of the combined companies to attempt to injure a company brought out for a legitimate purpose. But this combination will not be successful, as the new cable is sufficiently underwritten to ensure its being laid. I ask, 'How is it possible for Mr. Weaver, or any one else, to fix the revenue to be earned by the International Cable Company?' But I would point out to him, and all his party whom it may concern,

that if it earns only one-fourteenth part of that earned by the combined cables, with their £14,000,000 of capital, it will be in as good a position as they are. I am informed the heads of the combination are determined to do all they can to prevent the International Cable Company obtaining its capital (hence these letters in the newspapers). But if they are unsuccessful, then they intend to buy it up, as they have all other Atlantic cable companies but one. But I beg to tell them at once, they will not be allowed to do so."

The Protection of Submarine Cables.—A Reuter's telegram, dated Paris, December 1st, says: "The International conference on the protection of submarine cables resumed its sittings to-day at the Ministry for Foreign Affairs, and an interchange of views took place as to the date on which the convention of March 14th, 1883, should come into force."

The Jablochkoff Company.—We intimated in our issue of November 19th, that changes were about to be made in the managerial department of this Phœnix-like concern. We now learn that Mr. Reeves and Mr. Blenkarn are no longer in the service of the company. Mr. Reginald Newington, however, still retains his position as electrical engineer.

Clark's Standard Cell.—In our next issue we shall publish some very interesting experiments on the temperature co-efficient of Clark's standard cell. They were undertaken with the view of ascertaining the true cause of the variation of E.M.F., and the results, hitherto unpublished, have been placed in our hands.

The British Museum Lighting.—We have heard that the recent extinction of the electric light in the British Museum was due to the state in which the engine had been left by two men, who had received dismissal from the place. This, however, is not all. At a few minutes past four on Wednesday afternoon, owing to the driving wheel of the engine at the British Museum becoming disconnected, the whole of the lights in the building became extinguished. A curious scene ensued in the reading room, which was crowded with readers, on the electrician announcing that the defect could not be adjusted under an hour. Readers being held responsible for their books until given up, and the attendants being unable to see the vouchers until lanterns were supplied, a deadlock supervened for some time, during which it was impossible for anyone to leave. A similar crowd collected at the umbrella stand, where the attendants had to be furnished with lamps before the checks could be deciphered. To prevent further recurrences of this nature the addition of accumulators, sufficient to keep one arc lamp alight, is contemplated.

Elieson's Accumulators.—We understand that the new form of accumulators, constructed by the Electric Locomotive and Power Company, for use in connection with their electric cars on the London tram lines, are performing very satisfactorily, some of them having now been in use during 15 months. The company contemplate trying their system in connection with the propulsion of launches, and are having one built 85 feet in length, which it is expected, in the matter of speed, will excel anything hitherto achieved in this way.

Management of Accumulators.—In reply to numerous enquiries, we may state that the pamphlet by Sir David Salomons, which is reviewed in our present issue, is published by Mr. Baldwin, of Tunbridge Wells.

A Good Proposition.—It is rumoured that a movement is on foot with the view of arranging for an annual dinner to take place in connection with the Society of Telegraph Engineers. The idea is a good one, and we hope it may be favourably entertained by the members.

Fatal Shock.—Another death from that carelessness which is the result of familiarity with danger is reported by the *Electrical Review* of New York. On the 6th ult., Mr. Edward Kelly, an *employé* of the Brush Company at Cleveland, undertook to adjust a lamp on a live circuit, while standing on a balcony. The pliers with which he was working were but imperfectly insulated with rubber tubing pulled over the handles, a portion of one piece having split open, and bared the metal. There was one ground contact somewhere upon the line, and a second ground, formed through his body and the balcony diverted sufficient current to produce instant death. The flesh of the hand holding the pliers was burned to the bone.

A Paris Electrician gone Mad.—An electrician living in Paris, who had gone mad in consequence of having been mistaken for Pell, the watchmaker, lately convicted for having murdered his two wives, has been sent to a lunatic asylum. He had become possessed with the notion that he really was Pell, and when the agents went to arrest him, they found that he had barricaded his doors, and was preparing to defend himself with a halberd in one hand and a revolver in the other.

Electric Spectacles.—A simple arrangement has been invented by Mr. I. T. Leighton, of Callander, N.B., relating to electro or galvano-magnetic frames for spectacles, eye-glasses, eye-preservers, &c. In this invention two small plates or discs are provided, one of copper and one of zinc, or any other two metals, one of which is electro-positive to the other. The plates or discs are attached to the bridge or nose piece of the frame in such a manner and position as to be capable of free adjustment or removal altogether if required, and so as to rest comfortably upon either side of the nose of the wearer. The metal plates or discs are electrically connected by the bridge or nose piece itself, or by a suitable wire or conductor, or the wire may be coiled round the nose piece, thus connecting it with an electro-magnet, in which case the wire would be insulated. Similar discs are placed on or near the ends of the arms of the spectacles and connected electrically by means of the frame. A gentle current of electricity is generated by the action of the moisture of the skin upon the metallic discs, and this current, it is claimed, exercises a curative, soothing and strengthening influence upon the eyes, and the nerves and muscles in connection therewith.

The Royal Society.—On Tuesday evening last the anniversary dinner of the Royal Society took place at Willis's Rooms. The company included Lord Rayleigh, Sir Frederick Abel, Mr. W. H. Preece, Mr. E. Graves, Engineer-in-Chief, G.P.O., Prof. D. E. Hughes, Prof. Crookes, and Mr. H. R. Kempe.

King's College Engineering Society.—A *conversazione* is announced to be held this evening at King's College. A very interesting programme has been prepared and, amongst other attractions, the workshops will be open and the machinery in motion.

Electrical Engineering Football Club.—This club, which is in connection with the School of Electrical Engineering and Submarine Telegraphy, announces a ball to take place this evening at the Portman Rooms Baker Street.

Electric Light Switch.—We have had brought before our notice a simple switch with double contact for electric lighting purposes, a production of the Jablochkoff Company. It appears to answer its purpose well, and in addition to having a good appearance it is very much cheaper than most switches of the kind.

The Society of Telegraph-Engineers and Electricians.—The annual general meeting at the Institution of Civil Engineers, 25, Great George Street, S.W., will take place on Thursday, December 9th, 1886, at 8 p.m.

Honours to an Electrician.—Mr. R. von Fischer-Treuenfeld, formerly commanding officer of field telegraphs, has been created by His Majesty the King of Spain a Knight of the second class of the Military Order of Merit. Mr. Treuenfeld had the honour of dedicating to His Majesty the late King Alfonso XII. a work on military telegraphy, and he also contributed largely to the journal of the Spanish Royal Engineers, the *Memorial de Engenieror*.

Lighthouse Illuminants.—The *Liverpool Journal of Commerce* in an article upon this subject, confesses that it has not dealt with it before because its prejudices against electricity were too deeply rooted to admit of calm discussion, and then proceeds to object to the electric light on account of its dazzling properties in clear weather, and its lack of superiority over gas or oil in fogs. Our contemporary seems to be under a misapprehension. The electric light is as much superior to gas in the fogs experienced at sea as it is in clear weather. With regard to the too great strength of the electric light when the atmosphere is clear, one of the principal points of Dr. Hopkinson's able paper read at the British Association meeting at Birmingham, was directed to the suggestion that the intensity should be increased in thick and diminished in clear weather.

Submarine Warfare.—The *Times* states that the principle upon which the immersion and emersion of the new submarine boat, described in our last issue, depend is simply that of displacement. While lying on the surface the boat has a given amount of displacement. To effect immersion this displacement is reduced, and when it is desired to raise her to the surface again the displacement is increased. A fair analogy is that of a telescope dropped into the water when extended for use, in which condition it will float for a given time. If dropped into the water closed up it will straightway sink to the bottom. The idea of utilising this principle originated with Mr. Andrew Campbell, and was worked out in practice by him in conjunction with Mr. Edward Wolesley and Mr. C. E. Lyon, and the vessel in which the joint ideas of these gentlemen have been embodied has been built by Messrs. Fletcher, Son, and Fearnall, of Limehouse. This boat is cigar-shaped, and pointed at both ends, being 60 feet long and 8 feet in diameter amidships, exclusive of a slightly raised central deck. Her displacement when fully immersed is about 50 tons. She is built of $\frac{3}{8}$ inch Siemens-Martin steel and is driven by twin screws, the motive power being electricity which is supplied from a storage battery to motors of 45 horse-power. Electricity also supplies light, when submerged, by means of glow lamps. Air under pressure is stored on board and there is accommodation for a three days' supply; the electrical batteries also have a similar storage capacity. The electrical machinery has been designed by Mr. Graydon Poore and supplied by Messrs. Lewis Olrick & Co. When lying on the surface of the water a depth of only about 10 inches of the central upper portion of the boat is visible above water line, and this is surmounted by a steel conning tower about 12 inches high and 15 inches diameter and pierced with four sight holes. Entrance and exit are obtained by means of a manhole on the deck which is secured with a watertight joint, and there is room for six persons in the central portion of the boat. Displacement is increased or reduced by means of cylindrical chambers which are projected or withdrawn telescopically from the sides of the vessel, and by this simple means she can be made to rise or fall in the water, slowly or quickly, at the will of those in command. This was amply demonstrated in the West India Docks last Saturday, when Lord Charles Beresford, with others, went down in her, Lord Charles expressing himself very strongly as to the value of this new vertical manœuvring power. The boat was many times submerged to the bottom of the dock, about 17 feet, and brought to the surface again on a perfectly even keel. She was also propelled a short distance, connection being made with the batteries by hand, but as the motors were not coupled up with the current nothing further was attempted. The area for a run, moreover, was too circumscribed, there being a number of vessels lying in the docks, which would have impeded progress. The main application of the system would appear to lie in the direction of submarine warfare, although it is not intended that it shall subserve this purpose exclusively, as the inventors have designed arrangements for applying it to all classes of submarine operations in lieu of the diving bell. It is also to be observed that, although only applied to a 60 feet boat, this size in no way indicates a limitation of the principle, which can be applied to any sized vessel. The present dimensions were only adopted because they correspond to those of a second-class torpedo boat.

Researches in Electro-Dynamics.—The Royal Society's Copley medal has been awarded to Prof. Franz Ernst Neumann, for his researches in optics and electro-dynamics. Prof. Neumann, the *Times* says, is an old man, who has been studying with considerable effect for 50 years, and who has made discoveries in light and electricity which put him in the first rank of living men of science.

Society of Arts.—We would remind our readers that Major-General C. E. Webber, R.E., C.B., will read his paper on "Glow Lamps: their Use and Manufacture," on Wednesday next.

Obituary.—Mr. Octavius Edward Coope, M.P. for the Brentford Division of Middlesex, died on Saturday after a few weeks' illness. Mr. Coope was well known to our readers in connection with the lighting of Berechurch Hall, his yearly reports of the results of his experiments with the installation there being always scanned with much interest.

The American Institute of Electrical Engineers.—The third volume of the transactions of this society has reached us. The contents are of an interesting nature, and include papers on "Underground Electrical Systems," "The Great Tangent Galvanometer of Cornell University," "Some Recent Advances in Telephony," "Static Difficulties in Telegraph Wires," and "Secondary Batteries for Light and Power." Several of these articles have already appeared in the ELECTRICAL REVIEW.

The Mysteries of Secondary Batteries.—In a discussion which followed the reading of a paper on "Secondary Batteries," before the American Institute of Electrical Engineers, Mr. Mailloux said that all the difficulties which have been considered inherent in them have been overcome, and that not the least one of these difficulties was the formation of *sulphate of copper*. We would like to ask whether Sir David Salomons has ever come across this curious deposit in the course of his extensive experience? *Quien sabe?*

The Vienna Opera House.—The *Times* correspondent telegraphing from Vienna on Wednesday says:—"There is now a good prospect of the Opera being lighted next year by electricity. The British Gas Company in Vienna has long held a contract for the lighting, but the Municipal Council has thrown all sorts of hindrances in its way, by imposing conditions not required by the Imperial Government. Count Taaffe has at last interfered personally, by ordering that these vexations shall cease, and it is now being arranged that the Opera shall be closed next July for the alterations necessary to introduce the new system of lighting."

Sale of Engineering Plant.—At the Alliance Engineering Works, West Drayton, Messrs. Wheatley Kirk, Price and Goulty will sell, on Tuesday, Wednesday, and Thursday next, some valuable modern engines, machinery and plant, of which catalogues are now ready. Some of the lots are worth the attention of electrical engineers and contractors.

Electric Light Distribution.—It may interest our readers to know that the National Company for the Distribution of Electricity by Secondary Generators has just received information by cable from Pittsburg, U.S., of the successful opening of an installation of 4,000 lamps under the Gaulard-Gibbs system at Buffalo, by the Westinghouse Electric Company. The characteristic energy displayed in this work is evidenced by the fact that when the partner of Mr. Westinghouse, now in England, left the States rather more than two months ago, the negotiations for this installation were not even commenced.

New Appointment.—Professor Rücker, F.R.S., has been appointed by the Lord President of the Council to the Professorship of Physics in the Normal School of Science and Royal School of Mines, rendered vacant by the death of Professor Guthrie, F.R.S.

Kennedy's Electric Light Appliances.—Mr. Rankin Kennedy, of the Woodside Electric Lamp Works, Glasgow, has favoured us with a copy of his newly issued descriptive price list. It includes not only lamps and dynamos, but also steam engines specially made for electrical work. He believes that by manufacturing everything required—steam engines, dynamos, fittings, and lamps, and by adopting and recommending the best belts and other materials—he will be able in every installation of his system to meet with success, and at the same time effect a reduction in cost. Dick and Kennedy's patent high speed engine is made in sizes from 2 to 50 horse-power, is specially designed for direct driving of dynamos, is silent in action, durable and economical, requires very little fixing, and occupies very little space for its power.

An Electric Tramway Bill.—Among all the Bills of which notice has now been given for next Session there appears only one affecting electricity. That is a Bill for constructing an electric tramway at Littlehampton.

The Lay Torpedo.—Mr. Andrew Campbell, the inventor of the flotation portion of the new submarine boat, elsewhere described, appears to be one of the signatories to the Lay Torpedo Company. The supposition that the company is formed to work in connection with the vessel is therefore natural.

The Dynamicable Society.—At the meeting of the Dynamicables, which takes place to-night, the topic for discussion is to consider the best method of improving the position of the Dynamicables. In the last issue of the *Electrical Engineer* several methods were suggested, and we would refer our readers to our contemporary if they are desirous of becoming acquainted with the suggestions thrown out.

Gas Engines for Large Powers.—The works at Deutz, where Otto's gas engines are being built, are now, *Industries* states, busy with large motors of this class for driving mills and factories, instead of the usual steam engine. These gas engines are used in connection with a special gas-making plant, and it is stated that whereas the average consumption of an ordinary steam engine is $3\frac{1}{4}$ lbs. of coal per horse-power, the corresponding consumption of the gas engine is only $2\frac{1}{4}$ lbs., and this economy has induced several works to replace their steam engines by large gas engines. Amongst these works are the zinc rolling mill of W. Grillo, in Oberhausen, where ten gas motors supply an aggregate of 244 H.P; the Mechern Berg Werk Verein, where seven motors supply an aggregate of 174 H.P.; the Russian company for the manufacture of powder in Schlüsseburg, where 17 motors supply an aggregate of 194 H.P.; a sugar factory in Elsdorf, where six motors supply an aggregate of 191 H.P.; the water works of the town of Coblenz, with 120 H.P.; the municipality of Prague, with 150 H.P. (for electric lighting); and the opera in Frankfurt-on-the-Maine, with two motors having 100 H.P.

Test of an Edison Central Station Plant.—The Edison central station at Oskaloosa, Iowa, which was put in operation on August 1st with 1,000 lamps, has succeeded so well that 1,500 lamps are now in circuit, and an enlargement of capacity is under way. The plant is located beyond the city limits, at a distance of about a mile from the centre of lighting, and cheap slack coal is burned under the boilers. On account of the distance of the station from the centre of distribution a loss of 23 per cent. is experienced in the conductors. There are two slide-valve engines of 250 horse-power each in the station. They were built by the Iowa Iron Works, Dubuque, Iowa, and are provided with Gardner governors, which show a variation in speed of only 3·4 per cent. between maximum and no load. A recent test, published in the *Electrical World*, gave the following results:—I.H.P. of engine, with load of 627 ampères and 130 volts, 135·6 H.P.; ampères per I.H.P., 4·62 H.P.; ampères per H.P. delivered at armature, 5·69 H.P.; lamps per I.H.P. (100 volts), including 23 per cent. loss in conductors, 6·25 H.P.; lamps per I.H.P., 5 per cent. loss in conductors, 7·5 H.P.; lamps (100 volts) per H.P. delivered at armature, 7·70 H.P.; ampères, 6·27 H.P.; volts at brushes, 1·30 H.P.; watts at brushes, 81,510 H.P.; watts per I.H.P., 601·1 H.P.; percentage of I.H.P. delivered to circuit as electrical energy, $\frac{601 \cdot 1}{746}$, 80·5 per cent.; assuming 90 per cent. electrical efficiency, this would give a percentage of I.H.P. delivered to dynamo by belt, 90 per cent.; percentage of I.H.P. actually recovered as electrical energy in the lamps after loss of 23 per cent. in conductors, 62·5 per cent.

The Electro-Osteotome.—Dr. Milton J. Roberts, of New York, is said to have devised a new mode of examining diseased bones, which consists in boring into and lighting up their interior surfaces with the electric lamp. He describes his devices as follows:—"My aim has been to make as nearly a universal osteotome as possible; that is, an instrument, with which the surgeon can cut bone with ease, safety, and accuracy in any desired direction. As it is now constructed, it is provided with two headpieces, one for the carrying of various sizes of circular saws, and the other for the holding of drills and burrs of various shapes and sizes. By means of this instrument, a bone may be perforated with any size drill up to a quarter of an inch diameter, or a cross or longitudinal section of it made with as much facility as a similar wound could be made in the soft parts by means of a sharp scalpel. Once having positively determined the existence, site, and probable extent of disease, an incision is made down to the bone, and a large drill or trephine, from a quarter of an inch to half an inch in diameter, is carried through the bone into the diseased area or cavity. Upon removing this, smaller drills or burrs may be passed in through the opening thus made, and used to excavate the affected bone. For the thorough inspection of the parts, I have had constructed a miniature incandescent lamp, so small as to readily pass through a quarter inch drill hole. These lamps (half candle) furnish sufficient light to thoroughly illuminate the interior of any bone cavity." Surely some similar method of operating upon diseased bones in the human structure has been described before. This description of Dr. Roberts's instrument does not come to us with the suggestion of novelty.

Cremation by Electricity.—A movement has been set on foot in Italy towards erecting in one of the principal towns an electrical crematorium. In this edifice the bodies will be instantly consumed by means of an intense heat caused by electricity. Various European cremation societies are reported to have despatched representatives to Italy to make enquiries as to the feasibility of the scheme, which it is expected will, if successful, very soon replace the more elaborate methods now generally adopted. Partisans of cremation are sanguine that the introduction of electricity would instantly remove the objections held by many European States against the burning of bodies.

Sir John Bennett on Electricity.—Sir John Bennett last month delivered an interesting lecture to the members of the Northampton Club, Northampton Square, Clerkenwell, on "Electric Exhibitions at Home and Abroad." In the course of his remarks Sir John Bennett expressed his belief that London would never be upon an equality with great European and American cities in the matter of lighting, and in the utilisation of scientific inventions for the commonweal, until Londoners had an effective and efficient system of municipal government.

Natural Water Power and the The Electric Light.—The *Gas World* publishes an article under this heading in which it gives a negative view of the value of water-power for driving electric lighting machinery. It points out that for the satisfactory production of the electric light it is necessary that the driving-power applied to the dynamos should be constant, reliable, and considerably in excess of theoretical requirements. The waterfalls and torrents relied upon for a supply of power must consequently not be subject to serious diminution from droughts; they must not be liable to freeze; nor must large quantities of water be diverted from them at uncertain intervals for driving mills or for irrigation or other purposes. In this country the streams regarded with most approval by the electricians, namely, those which run most swiftly and abound in waterfalls, are liable to great fluctuations in the volume of their waters. Concluding the article, the writer says:—"One serious mistake made in respect of the electric light is that the chief, indeed the only, obstacle to its general introduction is the cost of the power required to drive the dynamos. This is not so. The cost of the maintenance of the machinery, secondary batteries where these are used, and other portions of the plant, is found to be so serious that this alone is found by experience to constitute a prohibition. It is well known that we have never pretended to shut our eyes to the possibilities and certainties of success attending the employment of the new illuminant in many directions; but, at the same time, we see no signs of its promising to come into extensive use for general purposes. Neither do we think that success will be achieved to any appreciable extent by resorting to the much vaunted natural water power."

A Time-Saving System.—It is suggested that the authorities at our Royal Dockyards might well adopt a somewhat novel system which has been found of immense value in the shipbuilding yards on the Clyde for the purpose of saving time and trouble. A tall flagstaff is erected on a spot visible from all parts of the works, and the various heads of departments and foremen have special signalling flags assigned to them. When any particular man is required by the manager his flag is hoisted, and on observing or being informed of the fact the person wanted repairs to the nearest telephone and communicates with his chief.

NEW COMPANY REGISTERED.

Lay Torpedo Company, Limited.—Capital £300,000 in £10 shares. Object: To acquire a certain secret process or processes for the manufacture of a torpedo to be called "The Lay Torpedo," and to acquire other machines or implements for use in connection with torpedo warfare. Signatories (with one share each):—Archibald Campbell, 1, Great Winchester Street (electrical engineer); C. S. Hill, Oak Grange, Beckenham; A. L. Hutchison, 4, Guildhall Chambers; W. B. Campbell, Sutton, Surrey; W. Hollick, 28, Barnsbury Park, N.; W. H. Helm, 7, Hillfield Road, West Hampstead; A. Watling, 78, Trafalgar Road, S.E. Registered, without articles of association, on the 26th ult. by W. Osborne Jones, 8, Mason's Avenue, E.C. Registered office, Basing House, Basinghall Street, E.C.

CITY NOTES.

Blackpool Electric Tramway Company, Limited.

BALANCE SHEET MADE UP TO THE 31ST DAY OF OCTOBER, 1886.

Capital and Liabilities.

DR.	£	s.	d.
Capital—Shares	19,997	10	0
Sundry liabilities (electrical fittings, ironmongery and smith's work, coal, oil, &c., £193 14s. 1d.; law charges, engineer's commission, salaries of secretary, managing director and auditors, directors' expenses, printing, &c., £431 2s. 1d.; rent of line, ground rent of shed, rates on office (borough and poor), gas and water, &c., £225 3s. 6d.; contingent fund, £2 4s. 8d.)	852	4	4
Disposable balance as per profit and loss account ...	1,853	10	2
Total	£22,703	4	6

Property and Assets and Preliminary Expenses.

CR.	£	s.	d.
Tram shed	2,357	18	10
Engines, generators, motors, &c.	3,167	6	1
Centre channel and electrical fittings	8,354	14	3
Cars, &c.	1,784	3	3
Mr. M. H. Smith, being the consideration for the assignment of the corporation concession and patent right for Blackpool, £2,000, and engineer's commission, £541	2,541	0	0
Miscellaneous capital expenses	556	5	1
Preliminary expenses (less bank interest and commission up to 31st October, 1885)	1,383	11	0
Stock	104	12	3
Debts owing to company (for interest on calls and iron, &c.	9	3	9
Cash (in bank and in guard's hands (change), £2,523 4s. 11d.; less owing secretary, £78 14s. 11d.)	2,444	10	0
Total	£22,703	4	6

REVENUE ACCOUNT, 1ST NOVEMBER, 1885, TO 31ST OCTOBER, 1886.

Expenditure.

DR.	£	s.	d.	£	s.	d.
Horsing and driving cars	115	9	11			
Wages of drivers, conductors, checkers, ticket clerk, engineer, electrician, stoker, &c.	1,092	5	5			
Electrical fittings, chains, collectors, &c., and repairs to electrical fittings, re-winding and repairing armatures, collectors, and other sundry repairs, &c.	301	2	5			
Coke, coal and oil	270	13	5			
Ironmongery and smiths' work ...	75	4	11			
Timber and joiners' work	28	12	0			
Rent for year at 6½ per cent. per annum on cost of line (£11,137 8s. 9d.) payable to Corporation of Blackpool under agreement ...	723	18	8			
Rent of ground for tram shed, from December 31st, 1885, to 31st October, 1886, at £35 per year, and rent of office, North Shore	45	13	10			
Income tax on profits, and rates and taxes on office, North Shore ...	42	13	1½			
Gas and water...	69	1	5			
Advertising, printing and stationery	45	6	8½			
Salaries of managing director, secretary, manager and auditor... ...	221	10	0			
Directors' expenses	65	11	3			
Fire and employers' liability insurance premiums	45	8	9			
Law charges	12	8	7			
Bank interest and commission ...	85	0	7			
Miscellaneous expenses — Licenses for cars, drivers and conductors, sundry travelling and other expenses...	94	13	7			
				3,334	14	7
Profit and loss for net revenue				1,791	2	8
Total				£5,125	17	3

Receipts.

CR.	£	s.	d.	£	s.	d.
Passenger receipts from cars ...	4,960	17	3			
Rents of advertising spaces on cars and tickets	165	0	0			
				5,125	17	3
Total				£5,125	17	3

PROFIT AND LOSS ACCOUNT.

	£	s.	d.	£	s.	d.
Balance in hand from year to 31st October, 1885	63	10	6			
Less excess rent of line 12th September to 31st October, 1885 — estimated charge £100—actual on ascertained cost, £101 3s.	1	3	0			
				62	7	6
Amount from revenue account, being profit from 1st November, 1885, to 31st October, 1886				1,791	2	8
Available balance				£1,853	10	2

The directors' second report, for the year ending 31st October, stated that the revenue account shows the sum of £5,125 17s. 3d. as receipts, and £3,334 14s. 7d. as working expenses, or a balance of profit for the year of £1,791 2s. 8d. Adding to this £62 7s. 6d. from last year in respect of the period from the opening (12th September) to 31st October, 1885, makes an available amount of £1,853 10s. 2d., of which the directors recommended the following appropriation :—A dividend of 5 per cent. on £20,025 (the called up capital of the company), £1,001 5s.; depreciation and reserve fund, £800; balance to next year, £52 5s. 2d.; total, £1,853 10s. 2d.

The annual meeting of the shareholders in this company was held on Saturday last, Mr. R. Horsfall, mayor of Halifax, presiding. In moving the adoption of the report, which recommended that a dividend of 5 per cent. be paid and that £800 be set aside as a reserve fund, the Chairman said that he met the shareholders with very much more confidence than he did at their last meeting. They had overcome many difficulties in the working of the line during the year, and he thought they had now got everything in a satisfactory condition, and that the company had been placed upon a sound basis. The company had not met with that support from the inhabitants of Blackpool, and the Corporation especially, which it was entitled to, and the directors had been compelled to appeal to the Board of Trade on the question of running the cars on Sundays—a proceeding which the Corporation had very strongly objected to. The dividend was declared, £100 were voted to the directors jointly as remuneration, and the retiring directors, Messrs. Morris (Halifax), Moseley, (Manchester), and Oddie (Halifax), were re-elected.

The River Plate Telephone and Electric Light Company, Limited.

AN extraordinary general meeting of this company was held on Wednesday at the offices, Walbrook, to consider resolutions for amalgamating the company (except as regards the Uruguay business) with the United Telephone Company of the River Plate, and winding up the company voluntarily. Mr. Thomas Lloyd presided.

The solicitor (Mr. Godlee) explained the salient features of the agreement, which, he stated, was dated the 22nd ult., and was made between the two companies named, Mr. Richard Rogers, of 34, Walbrook—on behalf of the United River Plate Telephone Company, to be incorporated—the Consolidated Telephone Construction and Maintenance Company, and Frank Williams Jones, of 131, Wool Exchange, the Consolidated Company being largely interested in the River Plate Company, and Mr. Jones being a director of the United Company. The agreement was conditional on the passing of the special resolutions for winding up, &c., within six weeks from the 22nd ult., and the adoption of the agreement by the liquidators of the two companies and by the new company, so that it should become binding on them before the 1st prox. Subject to this each of the two companies was to sell and transfer the goodwill of their business in the Argentine Republic and Paraguay and certain assets (set out) to the new company. The special clause in the agreement to which the Consolidated Company and Mr. Jones were made parties was the last, by which they agreed not to compete with the new company in the Argentine Republic or Paraguay, or assist any person or company to carry on any opposition to or competition with the new company in those Republics for 10 years from the date of the agreement, the new company agreeing on their side that if Mr. Jones ceased to be a director of that company before their annual general meeting in 1891, they would nevertheless pay him or his executors a sum not exceeding £166 per annum from the date of his ceasing to be a director up to the said annual meeting, together with the same proportion as he would have received of all sums above £1,500 which should be payable to the directors of the new company.

The Chairman said that the debentures to be issued would go to the old debenture holders—who, Mr. C. L. W. Fitzgerald pointed out, were giving up 2 per cent. interest.

Mr. Jones, in answer to Colonel Gouraud, said that the cost price at which the stock referred to was to be taken over from the United Company meant the invoice price. It was to be new and unused stock, and efficient for the company's business.

The Chairman and the solicitor having given other explanations, resolutions were unanimously passed expressing the expediency of the amalgamation of the company with the United Company, winding up the company, appointing Mr. Thomas Lloyd and Mr. C. L. W. Fitzgerald liquidators, fixing their remuneration at £500 between them; conferring on them all the powers of liquidators under the provisions of the Companies' Acts, with the assistance, as a consultative committee, of Mr. Quilter, M.P., Mr. Arthur Baker (of the Stock Exchange), and one other gentleman to be elected by them; approving the agreement alluded to, and directing the liquidators, on behalf of the company, to carry it into effect, with power to agree to such modifications in the Articles of Association of the new company as they might think fit.

The South of England Telephone Company, Limited.—The directors have declared a dividend of 6 per cent. per annum for the half year ending 31st October on the preference shares of this company.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of November was 3,076, estimated to produce £2,550, against 2,707 messages, producing £2,313 in the corresponding month of last year. The receipts for the month of August, estimated at £2,200, realised £2,165.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 26th were £5,637 after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for November amounted to £36,759 against £40,427 in the corresponding period of 1885.

The Eastern Telegraph Company, Limited. The receipts for November amounted to £30,817, against £36,245 for the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending November 26th amounted to £4,398.

NEW PATENTS—1886.

15385. "Constructing and fixing field magnets for dynamo-electric machines." P. B. ELWELL. Dated November 25.

15395. "Conveying electric currents." A. L. LINEFF, W. JONES. Dated November 25.

15403. "Preparing organic matter for metallisation by galvanic deposit." A. J. BOULT. (Communicated by La Société Anonyme de Metallisation Artistique des Animaux, Vegetaux, &c.) Dated November 25. (*Complete.*)

15405. "Portable electric alarms for engineers, platelayers and others, working on railways." W. G. OLPHERTS. Dated November 26.

15462. "Desiccating the insulating coverings of electrical apparatus." N. J. RAFFARD. Dated November 26. (*Complete.*)

15484. "Electric light lamp pillar." J. HORROCKS. Dated November 27.

15509. "Electric lamps." M. WHEELER. Dated November 27. (*Complete.*)

15523. "Electric short circuiting switches." A. BERNSTEIN. Dated November 27. (*Complete.*)

15545. "Transforming and distributing electric energy." R. DICK, R. KENNEDY. Dated November 29.

15551. "Electric alarms for use on railways at level crossings, &c." W. G. OLPHERTS. Dated November 29.

15563. "Magnetic galvanic battery." W. H. CANNON. (Communicated by A. M. Richardson.) Dated November 29.

15577. "Autograph telegraphs." H. J. ALLISON. (Communicated by the Writing Telegraph Company.) Dated November 30. (*Complete.*)

15647. "Telegraph transmitters." A. M. CLARK. (Communicated by M. Beshoar.) Dated November 30.

15653. "Making blocks, plates, or rods of carbon for electrical purposes." H. H. LAKE. (Communicated by E. Shaw.) Dated November 30. (*Complete.*)

15671. "Applying electricity to vehicles on tram and railways." F. WYNNE. Dated December 1.

15689. "Microphones." T. WALLACE, O. A. EN HOLM. Dated December 1. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

12982. "Improvements in constant speed electric-motors." W. M. MORDEY and C. WATSON. Dated October 28. 8d. Claims: 1. The combination of a system of mains supplying electric energy from an external source at a constant potential, with an electro-motor having the fields wound simply as a shunt to the armature, and having the field magnets of such dimensions, and wound with wire of such a gauge and length that they are very powerful relatively to the armature, the said combination being for the purpose of obtaining a uniform or approximately uniform speed, irrespective of load. 2. In the system of a shunt wound motor, arranged substantially as set forth in Claim 1, the use of a centrifugal device, substantially as described, for the purpose of inserting a resistance in the field circuit or otherwise

weakening the field strength if the potential falls below the normal or standard conditions or for reducing the amount of such resistance or otherwise increasing the field strength if the potential rises above the normal or standard conditions for the purpose of maintaining the speed constant, or nearly so, irrespective of load. 3. In the system of a shunt wound motor, arranged substantially as set forth in Claim 1, the use of a shunt solenoid or electro-magnet, substantially as described, connected to the mains or to the motor terminals, and arranged to insert a resistance in the field circuit or to otherwise weaken the field strength if the potential falls below the normal or standard conditions, or to reduce the amount of such resistance or otherwise increase the field strength if the potential rises above the normal or standard conditions for the purpose of maintaining the speed constant or nearly so irrespective of load. 4. The combination with an electric motor of a switch so arranged as to connect the shunt field magnet circuit to the mains before so connecting the armature circuit, substantially as described. 5. The combination with an electric-motor of an automatic device comprising an electro-magnet or a solenoid and an electric resistance both introduced into the circuit of the motor, an automatic spring or counterpoise weight and a dash pot, substantially as and for the purpose described. 6. The use in electric motors of field magnets wound with two or more wires or sections of winding with means for connecting the said wires or sections in parallel or in multiple series with one another, the arrangement being such that the said wire or sections of winding are in series with the armature at starting the electric motor, and after the motor is started are connected in series with one another, but in parallel with the armature, substantially as described. 7. In a shunt motor, substantially as set forth in Claim 1, the use for the purpose of facilitating starting of a field-winding in series with the armature in combination with short circuiting or reversing devices, substantially as described. 8. Causing a shunt wound motor, arranged substantially as described in Claim 1, to run at one or other of two or more constant speeds, irrespective of load, by varying the strength of the field substantially as described. 9. The construction and arrangement of brushes and brush holders, substantially and for the purposes described.

13704. "Improvements in electric meters." G. PITT. (Communicated from abroad by J. Cauderay, of Neuilly.) Dated November 10. 1s. 1d. Has for its object improvements on the electric meter described in the specification of the patent of May 9th, 1884, No. 7,515. The claims are six in number.

14129. "Improvements in microphones for use in telephonic instruments." J. S. SELLON. Dated November 18. 8d. According to the invention the contacts of the microphones are so arranged that they are protected by their form or position from any deposition of globules of moisture, preferably by forming one or more portions of them in the shape of a tube within which contact takes place. Thus, for instance, a short tube may be placed over the adjacent ends of two contact pieces which nearly meet, and the said tube may be a hole through a recess in a cylinder, bead, ball, cone, or other convenient piece of carbon or other suitable conductor—or a single rod of suitable conducting material may be made to pass through the said bead or tube making internal contact therewith, the current being led to the said bead or tube by a light wire or spring or by metallic foil. Or two fixed tubes or tubularly end fixed pieces may be used, they being caused to support a central piece shaped as a double cone or as a ball or of other suitable form, provided with a pair of protruding trunnions which fit into the cavities and are protected by the cavities, and a wire, spring, or strip leads the electric current to or from the said central piece.

1886.

7003. "A new or improved electro-magnetic transmitter or conveyance." A. H. REED. (Communicated from abroad by J. T. Williams, of America.) Dated May 25. 8d. Claims:—1. The combination with a series of three or more helices placed at suitable distances apart, and with a tube, trough, or track extending through said helices, of a hollow core or carriage which can freely pass through said helices, a series of circuit closers, one for each helix, detached from said carriage, and their connections with a dynamo machine, or other source of electricity, said circuit closers being actuated by the passing carriage, and serving to close and break the circuits through the successive helices in the series, substantially as described. 2. The combination substantially as herein shown and described, with a series of helices placed in line with each other, and with a magnetic core or carriage, which can freely pass through all the helices of a series of circuit closers actuated by the magnetic influence of the core or carriage, contacts for said circuit closers, and the connections of these contacts and of the helices with a dynamo machine or other source of electricity. 3. The combination substantially as herein shown and described of a tube, trough, or track, a series of surrounding helices, a magnetic carriage constructed to move upon the track through the helices, a series of circuit closers actuated by the magnetic influence of the carriage, and their connections with a dynamo machine or other source of electricity. 4. The combination with a metallic tube, trough, or track connected to one pole of a generator of electricity, of a series of helices which surround said tube or track, and one end of each of which connects with said tube or track, a series of contacts, one for each helix and connected to the other end thereof a series of magnetic circuit closers, one for each helix, and all connected to the second pole of the carriage constructed to pass through the successive helices, said circuit closers being operated by the magnetic carriage, substantially as described. 5. The combination with a series of helices, three or more, provided with a series of circuit closers, one for each helix, and a tube, trough, or track extending through the helics of a magnetic core or carriage arranged to pass through said helices in said tube, trough, or track, said circuit closers being actuated by the magnetic influence of the carriage, substantially as described. 6. The combination of a series of helices, two or more surrounding a tube, trough, or track, and a magnetisable core or carriage free and detached from the other parts of the apparatus and extending at least from the inside of one helix to the inside of the second succeeding helix, together with circuit closers for introducing the said helices into an electric circuit, substantially as described. 7. The combination of a helix, a magnet constructed to close the circuit through said helix, and a core or carriage constructed to pass through said helix and to actuate said magnet substantially as described.

PROCEEDINGS OF SOCIETIES.

Physical Society, November 27th, 1886.

Prof. W. G. ADAMS in the chair.

THE following papers were read:—"On a Method of Measuring the Coefficient of Mutual Induction of Two Coils," by Prof. G. CAREY FOSTER, F.R.S. The two coils are for convenience designated by P and S (primary and secondary). The method, as originally devised, consists of two parts: (1) Observing the swing of the needle of a galvanometer needle placed in series with the secondary coil when a current of strength, y, is started in the primary. (2) Placing the galvanometer and a condenser of known capacity, c, as a shunt between two points, A and B, of the primary circuit, such that the first swing of the galvanometer needle on completing the primary is the same as in (1). It is easily seen that under these conditions $\mathrm{M} = c\,r\,r_1$ where M is the coefficient to be determined, r = resistance between the points A and B, and r_1 = resistance of galvanometer and secondary coil. The method requires the value of y to be the same in the two experiments and facilities for varying r without altering y. To overcome these difficulties the arrangement has been modified so as to make it a null method. The connections remain the same as in (2), excepting that the ends of the secondary coil are connected to the terminals of the galvanometer through a variable resistance with no self-induction. If p be the resistance of the secondary coil and variable resistance when adjusted so that on completing the primary circuit the integral current through the galvanometer is zero, it is shown that $\mathrm{M} = c\,r\,r$ where c and r have the same meaning as before. For let A and E be the potentials of the galvanometer terminals at any time t, y the resistance of galvanometer, q the current through it, and N and L the coefficients of self-induction of the galvanometer and secondary coil respectively. Then considering the path from A to E through the secondary coil, we have

$$\mathrm{A} - \mathrm{E} = p\,x + \mathrm{L}\frac{d\,x}{d\,t} = \mathrm{M}\frac{d\,y}{d\,t}.$$

For path through galvanometer

$$\mathrm{A} - \mathrm{E} = q\,y + \mathrm{N}\frac{d\,y}{d\,t}.$$

Equating these and integrating from $t = 0$ to $t = \infty$, we get

$$p\int_0^\infty x\,d\,t - \mathrm{M}\,y = 0.$$

Since

$$\int_0^\infty x\,d\,t = \text{charge of condenser} = c\,y\,r$$

we see that $\mathrm{M} = c\,p\,r$.

It is easily shown that if $\mathrm{L} = \mathrm{M}$ then $\mathrm{A} - \mathrm{E} = 0$ for all values of t. Hence the galvanometer might in this case be replaced by a telephone. By inversion, the method could be used for determining the capacity of condensers in absolute measure if M be known. The author thinks the method will be useful for dynamo machines, and gave a series of numbers obtained by experiments on different coils, showing that it gives consistent results.

Mr. C. V. BOYS suggested that by arranging a switch to change the connections from (1) to (2) in rapid succession a steady deflection might be obtained, and thought that this would enable very small coefficients to be determined. Remarks by Prof. FORBES, Prof. ADAMS and Prof. PERRY were answered by Prof. FOSTER and Dr. FISON.

"On the Critical Mean Curvature of Liquid Surfaces of Revolution," by Prof. A. W. RUCKER, M.A., F.R.S. The paper is chiefly mathematical and deals with liquid surfaces of revolution

attached to two circular rings, the planes of which are at right angles to the line forming their centres. By "mean curvature" the author designates *half the sum of the reciprocals of the two principal radii of curvature of the surfaces.* Maxwell has shown in his article on capillary action (*Enc. Britt.*), that if the film be a cylinder, a slight bulge will cause an increase or decrease in the mean curvature according as the length is $<$ or $> \frac{\pi}{2}$ times the diameter If $l = \frac{\pi}{2} d$, then a small change in the volume of the surface will modify its form, but will not alter the mean curvature. Thus the mean curvature of such a cylinder is evidently a maximum or minimum with respect to that of other surfaces of constant mean curvature which pass through the same two rings at the same distance apart, and which differ but little from the cylindrical form. Hence the cylinder may be said to have a *critical mean curvature* when the distance between the rings is $\frac{\pi}{2}$ times their diameter. If the distance between the rings is altered a similar property is possessed by some other surface. The author's paper investigates the general relation between the magnitude and distance apart of the rings and the form of the surfaces of critical curvature.

If x is the axis of revolution, then the equations to a liquid surface of revolution is given by the expressions $x = a \text{E} + \beta \text{F}$, $y^2 = a^2 \cos^2 \phi + \beta^2 \sin^2 \phi$, where F and E are elliptic integrals of the first and second kinds respectively, of which the amplitude is ϕ and the modulus $\kappa = \sqrt{a^2 - \beta^2} / a$. As usual, $\Delta = \sqrt{1 - \kappa^2 \sin^2 \phi}$, whence $y = a \Delta$, and if $\kappa = \sin. \theta$, then $\beta = a \cos \theta$, and since $a > \beta$, a and β are the maximum and minimum ordinates.

The results show that as θ increases from 0° to 90° the surface of critical mean curvature is an unduloid with limits of cylinder and sphere when $\theta = 0$ and $\theta = 90°$ respectively. When θ passes from 90° to 180° the surface is a nodoid with limits of sphere, and a circle whose plane is perpendicular to the surface of revolution. In the third quadrant the surface is still a nodoid, the limits of which are a circle and the catonoid. Finally, in the fourth quadrant, the surface is an unduloid, the limits being a catonoid and cylinder. Experiments were shown proving that with cylindrical films, where $l < \frac{\pi}{2} d$, increase of internal pressure produced a bulging, whereas if $l > \frac{\pi}{2} d$ a bulging was produced by decrease of pressure. From this it is evident that if the interiors of two cylindrical films whose $l < \frac{\pi}{2} d$, be connected, stable equilibrium will result, whereas if $l > \frac{\pi}{2} d$, there will be unstable equilibrium. These facts were illustrated experimentally with great success. After some remarks by Mr. C. V. Boys the proceedings terminated.

The Society of Telegraph-Engineers and Electricians.

AN ordinary general meeting of this society was held at the Institution of Civil Engineers on Thursday, November 25th, Professor D. E. HUGHES, F.R.S., president, in the chair.

The minutes of the last meeting were read and confirmed, after which the adjourned discussion on Mr. Gisbert Kapp's paper on the "Predetermination of the Characteristics of Dynamos" took place.

Professor G. FORBES referred to the previous attempts made to bring before the electrical world methods to predetermine, to a certain extent, the characteristic of a dynamo from its design, and foremost among those attempts he pointed to the work of Frölich, who started with the assumption of a formula which tallied with the characteristic of a series wound dynano and which had been modified to suit different methods of winding, and which had been analytically investigated by Mr. Rücker in a paper before the Physical Society. In such work it always seemed to him that there was an attempt to jump too suddenly at the final result, viz., to find a formula which should agree directly with the working of a series wound dynamo, while it was probable that a much nearer approach to the truth would be obtained if the efforts were directed to the determination of the electromotive force at a given speed, or the intensity of the total induction through the armature when a given current in ampère turns went round the field magnets. Such a line Mr. Kapp had taken up, and it had also been followed in the paper by Dr. John and Dr. Edward Hopkinson before the Royal Society, a paper which he (Professor Forbes) pointed out would have been properly brought before the Society of Telegraph Engineers, seeing that it was essentially of a character suitable to that society, and also because Dr. John Hopkinson was a vice-president of that society. Mr. Kapp stood in a prominent position in the history of the problem from the formula he had presented in a paper before the Institution of Civil Engineers last year, and in which he had shown that the induction passing through the armature was the result of the magnetising force divided by the magnetic resistance. The laws governing magnetic induction in space were similar to those governing the distribution of an electric current, similar to those which govern the distribution of heat, and also similar to those which govern the motion of an incompressible fluid. Having so far referred to the past, he related his objection to certain points in Mr. Kapp's paper, and said that in discussing the paper before the Institution of Civil Engineers last year he had implored Mr. Kapp to abandon that most awful combination of centimetre-gramme-seconds units and of inches and minutes, which was included in z of his formula. It was the most incomprehensible brain-wasting invention that could have been devised, and it was becoming utterly impossible for any man not possessing very great leisure to be able to read intelligently Mr. Kapp's papers. Mr. Kapp might himself have become accustomed to the combination, but it prevented the intelligent reading of his papers by other people. Brain power was to most people a limited quantity, and it was cruel of a man in Mr. Kapp's position to impose a wasteful destruction of the brain in order to decipher his papers. Professor Forbes himself had not had sufficient time to interpret the exact meaning of two parts of the paper under discussion. Mr. Kapp had said that the numeric 1,440 represented the specific magnetic resistance of air in the arbitrary system of measurement he had adopted, but he had not found sufficient courage to prove whether it was so or not. Further, Mr. Kapp said that the initial specific magnetic resistance of iron was given by the numeric 2; that also he had not examined, and it might be right or wrong. But certainly one of the two figures was wrong, if not both, for it was known that the permeability of iron in its initial stage of magnetisation was really more than 720. That affected the whole reasoning in the paper, and while Mr. Kapp had most justly introduced a formula which gave a correct representation of the physical facts, he was inclined to think that the conclusions arrived at were erroneous because they were based on erroneous values of parts of the quantities, and it was only by a happy picking out of different constants that Mr. Kapp had succeeded in getting a curve to suit his observations. The formula z 1 = P divided by the resistance of the air space, plus the resistance of the field magnets, plus the resistance of the armature, clearly did not represent what were known as magnetic resistances, neither did P represent what was known as the magnetising force, but really the number of ampère turns. The true constant to be obtained was $\frac{4\pi}{10}$ × number of ampère turns. He might be wrong in the impression that the formula led to erroneous conclusions, but he certainly was inclined to think that it did so, especially when he noticed that the value of the magnetic resistance of the air that Mr. Kapp had spoken of was enormously larger than that of the polar space between the armature and the field magnets. In the paper by the Messrs. Hopkinson that proportion was by no means large, and the conductivity of the waste lines of force was very comparable indeed with the conductivity of the air space between the poles. Mr. Kapp's paper of last year had, he was sure, led a great number of people to study the subject more fully than they had done before; it had certainly led him to do so. At that time the methods he was working on were very imperfect, but he set to work to develop them more fully, and had realised the enormous waste in the lines of force not passing through the armature. In the brothers Hopkinson's paper the ratio of the lines of induction created by the magnetising coils to the number utilised in the field magnets was 132 : 100, which meant that 24 per cent. of the lines of force were absolutely wasted, 24 per cent. of the energy used in the field magnets was wasted, and, it might be said, 24 per cent. of the copper on the field magnets was almost useless. In his preliminary work he had adopted a somewhat analogous, though far inferior, method to that followed by the brothers Hopkinson, and for the future he intended to always employ the graphic method which they had elaborated. The general result was, that if the quality of the iron and the proportion of the waste lines of force to the useful lines of force were known, then the characteristic of the dynamo could be calculated with all necessary practical accuracy. After reading Mr. Kapp's paper he realised how important were those lines of force, and put to himself the question whether it would not be possible to calculate the conductivity of the surrounding air space, compared with the conductivity of the circuit of induction which was really useful. He made the attempt and succeeded beyond his expectation, and found that where possible errors existed they occurred in precisely those parts of the calculation which were of least importance. He tried the method on several machines, and, so far as he could judge, saw that it was actually possible to calculate, with sufficient accuracy for practical purposes, the value of the waste lines of force, or the ratio of the waste lines of force to the useful lines of force. But it was not until after the publication of the Hopkinsons' memoir that he was able to test the method with absolute rigidity, because that memoir, for the first time, published the full details of the design of a dynamo, as well as the full details of the performance of a dynamo, and he thought a suitable comment on Mr. Kapp's paper would be to bring before the meeting as concisely as possible the method in which the waste lines of force could be actually calculated in an example where both details were given. Some dynamos were very much more easy to make approximate calculation for than others; machines such as the Edison-Hopkinson, Crompton, Siemens, Phœnix, Weston, and others of the kind were comparatively easy; the Manchester dynamo was more difficult, and the Kapp dynamo was peculiarly difficult, owing to its configuration. But even with difficult machines, with the practice and judgment acquired by first working on the easier

types, he felt perfectly confident that the approximate value of the waste lines of force could be calculated with all the accuracy required in practice. He drew attention to two or three lemmas (fig. 2) which helped considerably in such calculations. The first was that when an air space existed between two iron surfaces the conductivity might be measured by half the sum of the surfaces divided by the distance between them. The second had reference to the conductivity between two iron surfaces in the same plane, separated from each other by a certain distance. The third lemma was exactly similar to the second, but the distance between the two iron surfaces was much greater, and a slightly

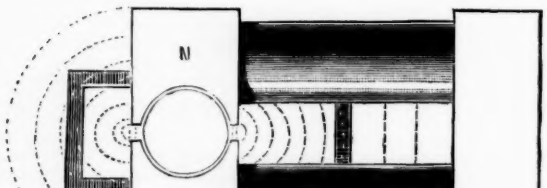
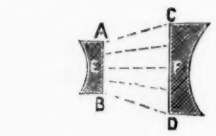


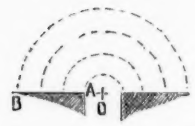
FIG. 1.

different conductivity value was obtained. The employment of either the second or third lemma depended upon the distance between the iron surfaces. In a dynamo, in which the bed-plate was separated from the machine by a zinc plate, it was necessary to



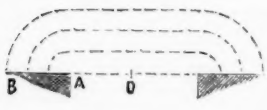
LEMMA 1.

$$\kappa = \frac{\frac{1}{2}(AB + CD)}{EF} \times \text{width.}$$



LEMMA 2.

$$\kappa = \frac{1}{\pi}\log_e \frac{OB}{OA} \times \text{width.}$$



LEMMA 3.

$$\kappa = \frac{1}{\pi}\log_e \frac{\pi . AB + 2OA}{2OA} \times \text{width.}$$

FIG. 2.

measure the induction from the end of a pole-piece down to the plate, and back again to the next pole-piece. Referring to fig. 3, the first source of leakage was from the end of the pole-piece to the bed-plate; for that, the first lemma was employed, and the calculated conductivity came out at 63. The next source of leakage was across the limbs, and consisted of two parts: one, being the leakage directly across the limbs, was calculated by lemma 1; the other,

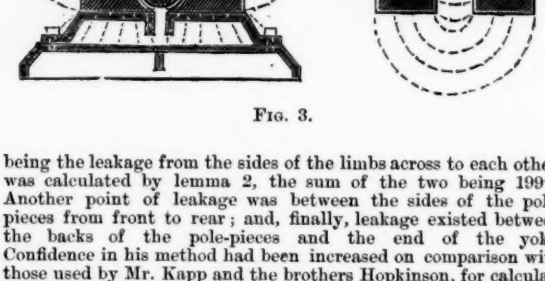


FIG. 3.

being the leakage from the sides of the limbs across to each other, was calculated by lemma 2, the sum of the two being 199·5. Another point of leakage was between the sides of the pole-pieces from front to rear; and, finally, leakage existed between the backs of the pole-pieces and the end of the yoke. Confidence in his method had been increased on comparison with those used by Mr. Kapp and the brothers Hopkinson, for calculating the magnetic resistance of the polar air space of the dynamo and field magnet. Great uncertainty existed in calculating the mean magnetic induction in the field magnets, the mean length of the armature, its mean section, and the mean section of the lines of induction from the armature, as well as in calculating the magnetic resistance of the air space from the pole-piece to the armature. (Experimental measurements described.) He could not be accused of prejudice in those experiments. The result for the conductivity of the air spaces which he arrived at was 524, as against 533, the result given in the Hopkinson paper. He had been working at a system of calculating the magnetic induction through air for nearly a year, and had prepared a skeleton paper for the society, but found that it was necessary to devise a machine

x_1	= ·12	κ_1	= 443
x_2	= ·21	κ_2	= 21·7
x_3	= ·07	κ_3	= 43·4
x_4	= ·001	κ_4	= 16
$\nu - 1 = x$	= ·40	κ	= 524

FIG. 4.

for testing the magnetic conductivity of iron with different magnetising forces. He believed he had now obtained a method, and if correct would describe it. The curve obtained by his experiments very closely resembled that of Mr. Kapp and the brothers Hopkinson. The question of wasted energy was an important one for the makers of dynamos. It had always been a mystery to him why the field magnets were not wound on two limbs instead of four; or why there should be any waste field to speak of. Mr. Kapp had said that the number of lines created must be greater than the number utilised, but he could not see why that should be so. What was wanted was to magnetise the armature and not the field magnets, and he could not see why the layers of wire were not wound so that the lines of induction would go directly through the armature, the waste lines would then be very few indeed, they would be outside the armature, and would assist in its magnetisation instead of opposing it. It might be stated

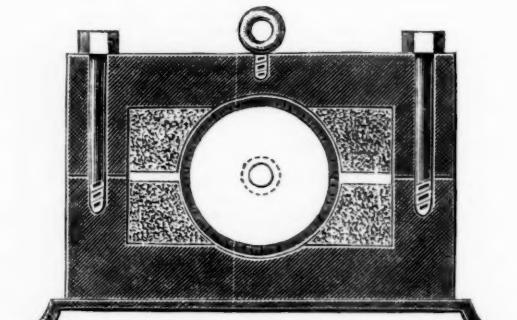


FIG. 5.

that mechanical difficulties stood in the way; that might be so at the commutator end, but he saw a way of avoiding that. Such an arrangement, the general idea of which was shown in fig. 5, would result in less iron being required, half the number of ampère turns would be sufficient, and the full number of lines of induction would be effectively utilised.

Dr. J. HOPKINSON: Admitted that the analogy of the resistance of electrical conductors introduced by Mr. Kapp and Prof. Forbes went a long way, but it would be almost better to set it aside and consider the facts of the case. The law that the current in any conductor was directly proportional to the difference of potential between its ends did not provide for the magnetising function of iron, which had not been satisfactorily expressed in algebraic form. In the arc lighting rage many people had been mistaken in the notion that the arc had a definite constant resistance, when it was much nearer the truth to say that there was a constant difference of potential in the electric arc. He strongly supported Prof. Forbes in urging Mr. Kapp to adopt the centimetre-gramme-seconds units. The absence of their application had prevented him from reducing the values of Mr. Kapp's formulæ. As to the waste field, he understood that Mr. Kapp had not made it the subject of any independent determination; but he had done so by a wholly independent method, based upon experience in electrostatic induction. Lord Rayleigh in his book on "Sound" dealt with the question of the extension of an organ pipe owing to its open end, and pointed out that the same method was equally applicable to the case of electrical conductors, and showed their extension when under the influence of a current. Mr. Kapp had given some figures of magnetisation which were extremely high, reaching 30,000 per square centimetre, a figure which he viewed with some degree of astonishment, as the highest figure that had previously come under his observation was in the case of the Manchester dynamo which went up to 20,000. It was extremely desirable that experiments should be made to ascertain the maximum induction obtainable in soft iron and in steel containing about 8 or 12 per cent. of manganese. Mr. A. Siemens had justly pointed out that there should be a large

factor of safety in dynamo machines so as to increase their durability. He believed that durability was best obtained by a high efficiency, as a machine of high efficiency would have less sparking and be better in every way. On the other hand, Mr. Swinburne thought that the great thing for dynamo makers to consider was cheapness of production. There he (Dr. Hopkinson) quite agreed, but there was a point where cheapness amounted to nastiness, and might be obtained by too great a sacrifice of efficiency. In considering the comparative economical efficiency of two machines, suppose that one machine saved a horse-power, what was the cost of that horse-power? Estimates varied according to whether coal or gas was used, but, without considering water power, perhaps £10 per annum could be taken; and allowing for 10 per cent. depreciation and 5 per cent. for interest on outlay, he considered that the higher efficiency would be worth paying for. Mr. Crompton had referred to the advantage of a good eye in understanding a dynamo; no doubt that was very great, but what was wanted was not to depend upon the eye or upon mathematics, but to have a combination of the two. Siemens once very truly said that mathematics was a good servant but a bad master, and the corollary to that was, that the best way of avoiding being mastered by your servant was to be master of that servant. Again, both graphic and algebraic methods had their proper places in studies of that kind; but the employment of an empirical law was not so good as the graphic method. It was better not to have a hard and fast rule, but a combination of analytical and graphical methods. He considered Frölich's law as dangerous, because it led one to think that that which was used as a combined expression of results obtained by experiment was really a law of nature. In conclusion, he heartily complimented Mr. Kapp upon his paper, who, whatever others had done in the same direction, had clearly worked out what he had placed before the society by his own unaided efforts with considerable success.

Dr. J. A. FLEMING remarked that after what Dr. Hopkinson had said, it appeared to be slaying the slain to emphasise the fact that no very simple algebraic formula could lead to the proper expression for the characteristic curve of dynamo machines. In a paper before the Royal Society Mr. Bidwell had explained some experiments on the magnetisation of iron rings subjected to great magnetising forces so as to arrive at the susceptibility of the iron, and it was clear that the reciprocal of that susceptibility was a linear function of the magnetic force, and that if the observations were plotted out showing the magnetic forces and the reciprocals of the susceptibilities, the result ought to be a straight line. Mr. Bidwell had furnished him with a table showing observations from 10 to 600 C.G.S. units, which when plotted out with a column showing the reciprocal of the susceptibility corresponding to each magnetic force gave a very approximate straight line. Below 10 units the curve deviated considerably. It was interesting to see that an empirical formula, although it could not be called a law, could represent within certain limits the relation of magnetic force to magnetisation within such limits. He cordially endorsed Dr. Hopkinson's remarks as to the value and interest of Mr. Kapp's paper; certainly a great departure had been taken by him and the brothers Hopkinson in dealing with the problems, as also in the work briefly sketched out by Professor Forbes that evening. It was a matter for congratulation that Englishmen had taken the lead in showing the way to a true theory of that most perfect engine, the dynamo-electric machine.

Mr. SIDNEY F. WALKER did not exaggerate, he thought, when he said that before Mr. Kapp's paper the dynamo was the master of the manufacturer, but now the manufacturer was the master of the dynamo. He had adopted Mr. Kapp's formula in the construction of dynamos, with the result of enormously increasing their out-put. The suggestion of Professor Forbes as to the winding seemed to be the natural direction in which to work; more iron was desired and less copper, and the limit of reduction was reached when the interest upon the increase of iron added to the cost of handling, was equal to the interest upon the wire saved and its cost of winding; there would then remain the saving in horse-power by the diminished leakage.

Prof. SILVANUS P. THOMPSON: Acknowledged the value of the calculations made, in their respective ways, by Mr. Kapp and Dr. Hopkinson of the actual working magnetism of a magnetising circuit. The curves arrived at by both papers were not the characteristic curves of dynamos but the curves of magnetisation of dynamos, which were different from what had for some years been known to electrical engineers as characteristics—Deprez introduced the term in 1881 to denote a curve representing the relation between the E.M.F. and the current of a machine, and such a curve had been introduced by Dr. J. Hopkinson in 1879, who compared it to an indicator diagram. The curves of Mr. Kapp and Drs. J. and E. Hopkinson did not represent watts, and might perhaps preferably be called curves of saturation. He believed that Mr. Kapp's paper did not refer to a series wound machine. He exhibited and explained to the meeting the characteristic of a shunt wound machine arrived at from the characteristic curve of its effective magnetism. He deplored Mr. Kapp's adoption of the C.G.S. units mixed up with the square inch as a unit of area, and a minute as the unit of time. He regarded Frölich's formula as sufficient for practical purposes, and considered that it suited the facts better than Müller's arc-tangent formula which Mr. Kapp had revived; especially after the recent simplifications which Frölich had introduced.

Prof. HUGHES said it was too late to ask Mr. Kapp to reply that evening, but he would do so at an extra meeting, which would be held on Thursday, December 2nd.

The meeting then adjourned.

CORRESPONDENCE.

Gas Works and the Electric Light at Hastings.

In the ELECTRICAL REVIEW of 26th ult. appears the following with regard to the Croydon Corporation: "The Mayor of Hastings said the electric light was an utter failure, obtain the gas by all means." . . . "We should like to know how many of these opinions were disinterested."

The Mayor of Hastings is a prominent director in the local gas company, and I understand has large pecuniary interests in it.

However, to contradict the "utter failure," the corporation have decided to continue the electric arc lighting for a further period of twelve months; that is, to November, 1887. The electric light company commenced supplying the corporation in November, 1883, so that some experience has been gained by them.

As to incandescent lighting, the Mayor can know but little about it, as he very much prefers gas, even in a first-class hotel.

Electrical.

Lithanode.

My attention has been drawn to several somewhat recent statements about a patent of Mr. FitzGerald's. It would appear that he makes a substance called lithanode for use in accumulators; but, as far as I can make out, this is simply peroxide of lead. I therefore think it right to point out that the use of peroxide of lead plates was patented by Mr. Tribe several years ago. As I have not seen Mr. FitzGerald's patent, I cannot say that his method is that of Mr. Tribe; but the statements I have seen indicate a close similarity.

W. Hibbert.

The Electrical Light and Photographic Transparencies.

In your issue of the 26th inst., on page 531, you refer to the recent Exhibition of the Photographic Society of Great Britain, and Mr. Sebastian Davis's remarks upon the adaptation of the electric light for use in the optical lantern. Some very practical and useful comments with reference to the preference of the electric light in lieu of the oxyhydrogen gas have been made, but would it not be of the greatest importance to your readers to acquaint them, besides only simple justice to the inventor, that the electric light shown at the exhibition above-described was "Schanschieffs's patent single-liquid battery?"

I have to add that I was present during the experiments, and that the battery, a single-fluid one, did work 2½ hours an "arc lamp," without any hitch whatever; also that the chairman of the meeting informed those who were present that the inventor, Mr. Schanschieff, has been awarded the society's medal; and, at the same time, expressed his hearty thanks on behalf of the society for his remarkable and useful invention.

Trusting you will be good enough to insert the above,

An Eye Witness.

November 30th, 1886.

[We have ourselves formed a very good opinion of the Schanschieff battery, and are pleased to insert the above letter.—EDS. ELEC. REV.]

House's Patent Telephone of 1868.

In your description on page 525 of the telephonic instrument patented in the United States in 1868 by Royal E. House, the well-known inventor of the printing telegraph that bears his name, the remark is made that in a certain respect it strikingly resembles Bell's instrument patented eight years later. Allow me to point out that the resemblance is even closer than the writer of your article appears to think. In both the House instrument of 1868 and the Bell instru- of 1876 there is an electro-magnet, in both an armature

elastically mounted so as to vibrate in front of the poles, in both a membrane or diaphragm distinct from the armature, and possessing good acoustic properties, in both a hollow mouthpiece to which to apply the ear. The resemblance is indeed so perfect, that it is difficult to understand that any Patent Office examiner, if competent for his work, could have allowed a patent for the second in face of the prior existence of the first.

But will you also allow me to point out that, striking as are the above points of resemblance, there are some still more striking between the House instrument and another still earlier one, which was never made the subject of any patent, either in the States or anywhere else. I refer to the form of instrument devised by Reis, and described by Legat in 1862, six years before House, fourteen before Bell. In that instrument there was an electro-magnet with an elastically mounted armature, even pivotted, as in the House instrument, and provided with an adjusting screw to regulate its position, as in the House instrument. There was, however, no diaphragm, only a thin sonorous wooden lath to transmit the vibrations to the air; and, according to the description, there was, or might be, a mouthpiece in the form of "an elliptically-arched cavity," at the focus of which the ear of the listener might be placed. In this latter respect the resemblance between the House instrument and the Reis instrument is perfect. Yet House appears to have arrived at his "electro-phonetic receiver" in entire independence of the prior researches of Reis.

It seems almost incredible that, in the fierce light that has of late been thrown upon telephonic matters in the States, this instrument of House should have remained so long unnoticed. That the authorities of the U.S. Patent Office should have ignored it is not strange to anyone who is acquainted with their ways; of which, indeed, your own columns (p. 534) furnish a most instructive example. That in October, 1886, a patent should be granted to Messrs. Gaulard and Gibbs for a thing for which an application was refused to Mr. Bernstein in January, 1883, may seem strange. But it is entirely explained when we learn from Mr. Bernstein that the reason why his application was refused was because it did not fit in with the very limited stock of scientific knowledge of the Examiner of Patents. The examiner refused to allow a patent for an invention that did not work on the principles held by the Patent Office in its wisdom to be gospel truth. This is by no means the first instance where the U.S. Patent Office has set itself up to be a great authority in science, refusing to allow anything to be invented that doesn't fall in with its own notions of what the laws of nature ought to be. It has, for example, refused to Macdonough a patent for his telephone receiver, not on the ground that there was anything wrong with the receiver itself, but on the ground that his transmitter could not transmit speech; or, rather, that according to the official theory it could not. Unfortunately for the official theory, that Macdonough's transmitter can not transmit speech, his transmitter, when tried, actually does transmit. Yet the patent for the receiver is still withheld from Macdonough on the sole ground that the transmitter is theoretically incapable of transmitting! This may be clever manœuvring; but it is gross injustice. But the little gods who think to dictate science from the heights of the U.S. Patent Office, and lay down the laws of nature in their own way, are not only occasionally unjust but ridiculous.

Silvanus P. Thompson.

A Warning to Inventors.

I notice in your issue of the 19th inst. a paragraph headed "Mr. Holroyd Smith Abroad," and think that in defence of myself and as a warning to others an account of what really happened should be published.

The facts briefly are these: Mr. Plint applied to me twelve months ago, wishing to negotiate for the purchase and working of my Continental patents, and introduced M. Goryon, a wealthy Frenchman, as prepared to supply him with the necessary purchase money, which was to be paid in periodical instalments after my system had been successfully demonstrated in France.

Mr. Plint undertook to defray all expenses connected with the demonstration.

In order that the outlay might be as little as possible I sold him all the plant used at the "Inventions" at half cost price; for this he paid me, and the work was proceeded with.

Mr. Plint ordered from me a new car, but when it was ready, wrote saying he could not pay for it before delivery, because M. Goryon, fearing failure, would not advance him any more money until he saw the car running. Having absolute confidence in success, I sent the car, and also a powerful compound wound dynamo to be used as generator. I waited nearly three weeks, and not hearing of their safe delivery went to Paris, and found my car, &c., in "Douane," and advanced Mr. Plint £80 to clear it, and hastened to get it upon the line. When there my suspicions being aroused, I made enquires, and found that M. Goryon had advanced Mr. Plint £1,200 for the demonstration work, and whether I was paid or not could claim my car and machinery if I permitted it to be unpacked and worked.

I at once took legal advice, and acting upon it, hired a piece of ground, and removed to it my car and machinery. Then having no agreement at all with M. Goryon, and learning that he was not bound to supply Mr. Plint with the necessary money to purchase my patents, and knowing that Mr. Plint could not purchase them himself, I insisted upon the cancelling of my agreement with him (Plint). I then hired from Mr. Plint the field where he had laid the rails, returned my car, and ran it to the satisfaction of all who saw it. Before the time of rental expired I removed the car to my own land.

As no payment for my car was forthcoming, and no guarantee for the purchase money of my patents, I proceeded to warehouse my property in Paris. Then followed a series of complicated legal proceedings and annoyances that it is unnecessary to mention. It is, however, in some degree satisfactory to say that the French court has declared the car and machinery to be my property.

M. Holroyd Smith.

November 27th, 1886.

Welding by Electricity.

In connection with this matter, I must call attention to the fact that Captain W. Blanch Brain—with whom by way of calling up the fact of his being one of the earliest practical electrical engineers, I may remark I have the pleasure and historical honour (in connection with the British Electric Light Company, Limited) of having been associated during the experiments and investigations he made in the electric transmission of power, which resulted in his obtaining upwards of 80 per cent. efficiency on the motor at a time when men more *purely scientific* (?) held that 50 per cent. was the possible maximum, and which experiments also resulted in the first installation of electric power transmission for colliery purposes in this country,—I say that I must call attention to the fact that he, in 1884, was at work on welding by electricity.

Evidence of this exists.

It appears that he was before Prof. Elihu Thomson (I am not aware of the date of this gentleman's patent) and Mr. Duncan.

No doubt these gentlemen will readily accord Captain Brain his due as a pioneer, and Prof. Thomson can well afford with his great activity and energy to do so.

"Y. O. Y.," in the ELECTRICAL REVIEW of November 26th, appears, however, to show that to Mr. J. P. Joule is due the initiation, of what the industrial world may rest assured is a process with a most important future.

Radcliffe Ward.

November 30th, 1886.